The
Tropical Agriculturist
February, 1933

EDITORIAL

SOME THOUGHTS ON PRODUCTION

A summary of the figures of production and trade relating to plantation crops has recently been issued by the Empire Marketing Board and furnishes most interesting matter for contemplation.

The average values of the world's trade in rubber, tea or tobacco for the years 1926-31 were greater than those in beef, pork, maize or barley. In other words, on the whole, countries tend to produce their food more at home and import their luxuries from outside. The very reverse of conditions in Ceylon. A much higher proportion of the world's tobacco crops enter international trade than of dairy produce, meat or grain. To what an extraordinary state do many of the producing countries of plantation crops find themselves in the dangerous situation of depending very largely, too largely, upon one staple! The value of Ceylon's tea consists of some 52 per cent. of her total exports. Sugar constitutes over three-quarters of the value of the exports of Cuba and over half of that of those of Dominica, Hawaii, Porto Rico, Barbados, British Guiana and Fiji. Brazil, Columbia, Costa Rica, Guatemala and San Salvador depend for over 90 per cent. of their trade upon coffee. The Gold Coast to 80 per cent. upon cocoa. One half the export trade of British Malaya is in rubber in comparison to one-fifth in the case of Ceylon. One half of the value of the export trade of Greece and three-quarters of that of Nyasaland consists of tobacco. Zanzibar lives largely on her trade in spices, mostly cloves, which constitute 68 per cent. of the value of her exports. India and the United States are the largest consumers of cloves.

Whilst the Empire is the world's largest exporter of Tea yet on the whole she is not a net exporter of the commodity. The Empire production and consumption approximately balance.

India's chillies go mostly to Ceylon and seven per cent. of her ginger. In both of these Ceylon could be more than self supporting. India enjoys a large export trade in ginger with Aden and Arabia, less than one-quarter of her shipments of this spice go to Europe. The sole spice in which Ceylon possesses a monopoly is cinnamon of which Mexico is the largest consumer, Spain and the United States coming next in order.

The world's total production of tobacco is more valuable than that of sugar although less than one-tenth the quantity. The average value of tobacco exported from Cuba is some £180 a ton in comparison to £123 from the United States, £89 from the Dutch East Indies and £60 from India.

The area of the world under sugar is estimated at some 20 million acres. There are over 12 million acres under coffee and about half that under tobacco. Plantation rubber covers nearly 8 million acres, cocoa about 3½ million and tea under 3 million. The world's area under sugar is about one-quarter of the wheat area in Russia, which is about the same size as the rice area in India, and one-fifth of the area under maize in the United States. The world's area under coffee is less than that planted with wheat in France.

THE CULTIVATION OF FRUITS IN CEYLON WITH CULTURAL DETAILS—IX

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GROUP D

SOME FURTHER FRUITS FOR MID-COUNTRY SEMI-DRY ZONE (2,000-4,000 FEET)

(4) FIG. (*Ficus Carica*).—The edible fig is a native of Turkey and of the Mediterranean coastal regions and can be termed a fruit of the warm temperate zone. Few fruits are of such ancient origin and, as with the date, it is a prominent article of diet in the countries where it is commonly found. Though the fruit is largely consumed in the raw state, the export of figs from the Mediterranean region either dried, preserved or canned, has attained enormous dimensions and it is doubtful if there is any country in the world where this fruit cannot be purchased in its preserved or dried condition. Ceylon is no exception, yet the fruit can be quite successfully grown in the up-country drier zones such as the Uva and Uda-Pussellawa districts and to a lesser extent in the semi-dry low-country. Up-country areas subject to a strong South-West monsoon must however be ruled out for owing to the heavy monsoon rains invariably setting in when the trees are in bearing, the fruit is rarely allowed to ripen on the tree and in consequence lacks flavour.

In Ceylon the fig tree is one of small dimensions, often spreading in habit, and deciduous. In parts of California however certain varieties attain very large dimensions, one specimen being reputed to have attained a stem diameter of 3 feet and 80 feet in height, whilst another of spreading habit covers an area of 200 feet in diameter.

The soil best suited to the fig is that of a heavy nature, retentive of moisture but well drained since a soil of a very sandy nature renders the plant subject to attack by Nematodes (eelworm). The rainfall necessary to grow good figs varies much and is guided by factors such as the nature of the soil, the position in which it is grown and the variety. Generally speaking however a dry locality is best with ample water during the period the fruits are being developed, but dry conditions at time of maturing and ripening.

Shelter from strong winds should always be afforded and as a fruit tree for the home grower with a limited area the fig is to be recommended. Excellent fruits are obtainable where the tree is planted against the house or a garden wall or fence, the necessary protection being thus afforded in conjunction with a resultant root restriction much beneficial to this tree.

Propagation is almost without exception from cuttings, the well ripened shoots of the previous year's growth or even older wood being selected. New varieties are, however, obtained from seed.

The shoot should contain 3 to 4 good plump buds, the length of cutting necessary being guided by such though 5 to 6 inch cuttings are usual and inserted in prepared beds of loose sandy loam texture at distances of 6 to 8 inches apart and a foot or more between the rows. There is no necessity for eventual potting of the cuttings as these can be planted direct to their permanent site when the cuttings have sufficiently rooted and formed sufficient growth. The best period for such removal is when the first flush of growth of the new cutting has matured and not when the shoot is in active growth.

Planting distances should be from 12 to 15 feet apart, and the plants trained in tree or bush form, but if planted against a wall or house the branches can be trained horizontally with advantage.

In each case good sized holes should be given them and well decayed cattle manure in moderate proportions should be mixed with the soil when refilling the hole. A frequent dressing of manure or a good mulch is of special benefit as the fig is a shallow rooted tree.

A few fruits will often be produced on the first year's growth but more generally two years is the period for the first fruits to form, the crops increasing from thence onward and, as with the grape and some others, the fruits are formed on the young wood, and cultivation should be such as to encourage few and strong shoots. Pruning will consist of the removal of all weak and superfluous shoots and the removal of all root suckers to allow the vigour of the tree to be utilised in the remaining strong shoots, but heavy pruning of the fig is not generally desired.

Pollination is an important factor to the commercial grower as the varieties in cultivation are numerous. Certain varieties, and usually the best, such as the Smyrna-fig are not self-pollinated and need interplanting with the wild Capri-fig (valueless in itself) which bears within its fruits the fig wasp. This wasp is

the all important agent which cross-pollinates the flowers of the Smyrna and similar figs without which these varieties will not set perfect fruit, the process being termed caprification. This is an essential requirement now fully understood by the orchardist, the principle, though not to the same degree, being applied in northern countries in the growing of Apples, Pears and Plums, the object here however being more in the direction of improving the cropping qualities of shy bearers and elimination or reduction to the minimum of the number of windfalls. Effective pollination or cross-pollination does have this effect and in tropical fruits the principles apply to the Avocado Pear and many of the Anonas also.

Certain varieties of the fig are however self-fertile and are recommended for Ceylon since these have been and are being grown here at the present moment. These are the "Black Ischia" of medium to large size, bluish black in colour and of good quality; "Brown Turkey" a large pear shaped fruit of copper colour and of excellent quality, and the "White Ischia" a fruit of medium size, greenish yellow in colour, of rich quality, sweet and very productive. The latter has in fact been grown at Hakgala in the wet zone and given good crops in past years. The "White Adriatic" is another that has proved suited to Ceylon, and the "Coleste" is a very sweet fig that might be imported with advantage.

The majority of the fruit is disposed of commercially in the dried state and the fruit needs to be handled with much care and cleanliness. Fully ripe figs at the stage of shrinking only must be utilised and these should be dipped in boiling brine of the strength of three ounces of salt per gallon of water and exposed to the sun on clean trays, turning the fruit over so that both sides of the fruit are exposed for about the same period. They should be dried in the shade and then sweated in boxes, finally washing in a weak brine, again dried and packed.

(5) PERSIMMON (*Diospyros Kaki*) is an edible fruit much grown and relished in China and Japan and generally known as the "Kaki" or "Japanese Persimmon" or "Date plum". It is a very close relative of the Philippine velvet apple often found in cultivation in the low moist country of Ceylon but is much superior to it as a fruit. It is considered by the Japanese as a very valuable fruit and one of their best, being cultivated in both Japan and China on a large commercial scale. It is also cultivated in most sub-tropical parts particularly in the Mediterranean regions, and America has by grafting the fruit on a local stock now taken up the cultivation of this on a commercial scale.

Though the Japanese Persimmon has been in Ceylon since 1889, its cultivation has not to date been taken up to any exent and only a few plants here and there are to be found. In the drier parts of the intermediate zones of Ceylon such as Uva and Ragala it could be grown to advantage but the plant has many peculiarities to which other fruits are not generally subject. In the first place the species is diœcious so that for every 8 or 9 pistillate or female trees, a male tree is necessary. Growers realise this, and as with Apples and Pears and certain tropical fruits, groups of pollenisers are available, the variety "Gailey" being that generally used. There are however well over 100 good edible varieties of this fruit and certain varieties such as "Tune-Naski" and a few others are self-fertile so that if such are used the need for a purely polleniser tree does not arise. Also of this large number of varieties some are seedless and some not, all are astringent but the varieties are generally classified in two groups, those that lose their astringency when ripe and turn sweet, and those that seldom or never lose their astringency—the former being generally used for dessert purposes and the latter for preserving or drying in the same way as the fig is treated. The latter group do however lose their astringency if subjected to a special process of curing but this curing is a complex matter consisting of alcoholic treatment, and keeping in hermetically sealed tubs for a period of 15 days or so, and is hardly practicable in Ceylon at the present stage.

For local purposes therefore it would be well at this juncture to advise selection of such varieties as are (1) self-fertile (2) seedless, or nearly so, (3) sweet when ripe, and the varieties given later will include such selection.

The Persimmon is a small sized tree rarely exceeding 15 feet in height, of normally compact and handsome appearance and bears fruit of 3 inches to 4 inches in diameter varying in colour from orange-yellow to a dark-purple. It is normally globular in shape, thin skinned, and has an orange coloured pulp of sweet and pleasant flavour and very few seed, rarely more than eight, and often seedless or with only one or two seeds.

It is well suited to the semi-dry intermediate elevations and is essentially a sub-tropical fruit requiring similar treatment to the Fig. It requires plenty of water at the root but does not need much atmospheric humidity. A deep heavy but well trained soil with plenty of humus gives the best results.

Propagation is by budding and grafting, and usually low down on the stem. The Japanese and Chinese use their local or common Date plum (*Diospyros Lotus*) mainly as a stock as

this gives a much longer lived tree. Owing to scanty material and resources budding of this fruit for local distribution has not yet been accomplished, but the nurserymen of Japan and the Southern United States do bud upon own seedlings also, and as Ceylon possesses no near relative of the Persimmon common to up-country regions, budding on own stocks locally must be recommended.

Seedlings are normally raised and budded in the nursery beds, and growth being slow it takes two years for the seedlings to reach budding or grafting age. Cleft or whip grafting as described for the mango should be a suitable mode for this fruit and transplanting to permanent sites should be undertaken as soon as the grafted plants have completed and matured their first flush of growth. When planting out, each plant should be given an area of 15 ft. by 15 ft. at the minimum, or 18 ft. by 18 ft. at the maximum, good holes being afforded to which plenty of humus has been added. The plant, either seedling or grafted, should be headed at about 2½ feet from the ground to obtain the best formation, and pruning limited to removal of any subsequent weak growth or dead wood. Frequent mulchings in the growing season is recommended and where grown on a commercial basis, leguminous cover crops are an advantage to the plant.

Crops vary as to quantity, colour of flesh, size and shape of fruit and even in the habit of growth and foliage, according to variety, some assuming a very dwarf habit. Pollination is as before mentioned, a very important character in fruit formation and trees growing in a dry locality will set a greater number of fruits than in a wet locality.

The following is a selection of some commendable fruits at present in cultivation of which a few may probably be in the Island, at the moment though the original trees at Hakgala were imported as an unnamed variety of *Diospyros Kaki* from Hong Kong and as seed from Florida of *Diospyros virginiana*.

I. *Tamopan*: a variety from China, fruit seedless, not astringent, large 4 to 5 inches across and weighing one pound or more, deep golden red in colour, and the tree a strong upright grower.

II. *Tane-Nashi*: a large fruit, 3 to 4 inches across, skin yellow changing to bright red, seedless, yellow flesh. A vigorous grower and the best of the older varieties and is not astringent when ripe.

III. *Twentieth Century*: a new variety from Japan with fruit flat and large, 3 to 4 inches across, sweet, juicy, not astringent and of fairly robust growth.

IV. *Hyakume*: an oblong fruited variety with large fruit of 4 inches by 3 inches in diameter, light yellow skin, flesh dark brown, sweet and crisp, few seeds, not astringent and a popular market fruit in Japan and America.

V. *Hachiya*: a fruit oblong to conical, large, 4 inches or more in diameter, skin bright red with dark spots, flesh deep yellow, astringent when unripe, sweet when ripe. The principal variety used for preserves and dried fruit.

VI. *Fuyugaki*: a new variety, fruit medium, size $2\frac{1}{2}$ inches by $2\frac{1}{2}$ inches, skin deep orange red, flesh firm and sweet, never astringent, a few seeds, one of the best commercial varieties.

PROBLEMS ASSOCIATED WITH THE ESTABLISHING OF A LOCAL TEA CHEST INDUSTRY

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FOR two particular reasons, namely the value of doing what we can to build up local industries, and, the need to insure supplies of reliable packages in which to export our product, the interest now being taken in this subject is a timely one.

It might be claimed with some justice that methods of distributing and connected advertising have failed to keep pace with increasing production, and the tuning up that is going on over estate detail. In this connection the suitability or otherwise of the containers in which our tea travels is a matter of more than passing interest.

I take it that it will not be disputed that three-ply chests stand alone from the point of view of security, compared to these I class *momis* as only justified because of the special need of economy under existing conditions and locally made chests as undesirable in spite of their possible cheapness.

Superintendents of godowns in Colombo and those who are in touch with warehousing at the other end could perhaps give valuable information—comparing the various packages used, but they may not view the question of damage in the same light as we do. Loss of contents and taints there may be but it is doubted if the distributor's knowledge of the subject enables him to realize how much the good work attempted on the estate can be discounted by damage in transit.

A bus man's holiday appeals to the planters just as much as it does to any other worker, and in travelling I have found two things of particular interest—one being to observe how our product is treated in transit, the other to study the way it is advertised. My last trip was via Africa in 1930, and in the many ports touched at I never failed to come across tea. I made a special point of examining packages whilst being unloaded, in the dock warehouses and in dealers' godowns and if my memory serves me aright found that three-ply containers stood up to their job very well, but ranging from chests sprung at the cornering to badly smashed ones, I saw no straight wood packages free from damage.

To deal more directly with the possibility of building up a local Chest Industry.

From the latest Directory I have I see that in 1929 we imported 4,757,127 of what are classed as "Tea Chests and Shooks" their value being Rs. 6,284,901/-.

We are studying the problem of local chest production from varied points of view, but the bigger and more attractive aspect of this question concerns likely afforestation and the future. Whether we can find a suitable timber for the purpose and turn out satisfactory ply-wood packages is a matter of some doubt.

As far as straight wood chests are concerned, we have a number of suitable woods, which if properly seasoned and made would compare well with *momis*.

In discussions, borer attacks are referred to as a serious problem, but at the same time it has been clearly indicated that this is mainly due to faulty seasoning. I have in my office a considerable collection of tea chest wood samples—these have purposely been kept without precautions against borers and the damage done is much less than one would expect, I have had these specimens over 12 years.

I have at various times used "country chests" and records show that in 1917-18 when the imported article was poor in quality and prohibitive in price, I used 16,000 locally made packages, made from selected trees in the neighbourhood, of these I class as excellent chest woods:

Doona congestiflora, S. Tinniya, this is a very large tree, partly gregarious, weight seasoned 36 lb. per cubic foot. Could this wood be worked up with proper wood working machinery it would be on a par with momi.

Mangifera Zeylanica.—(Wild Mango) S. Etamba, is another good wood for the purpose. This is also a very big tree, a solitary grower and probably commoner than Tinniya, weight 44 lb. per cubic feet, requires seasoning.

There are numbers of equally suitable trees and in quantities such as *Myristica laurifolia*, S. Malaboda, that are good provided they are especially seasoned.

Special handicaps under which locally made chests labour are faulty seasoning and bad manufacture. If chests are to be hand made, they would be more attractive and also stronger if planing were done with a straight faced plane and not with the curved shaped blade beloved of the village carpenter—Again locally made chests are weakened by the way cornering is done —the cost of proper cornering machinery is prohibitive and hand

cutting is a definite cause of weakening, this is accentuated by the rough and abrupt faced chisel and the equally rough and irregular toothed saw with which the work is done.

In so far as existing timber trees are concerned, outlay on sawing, planing and cornering machinery can be ruled out as prohibitive, as such expenditure would only be justified if it were possible for unlimited quantities of suitable logs to be economically transported to the saw mills.

Looking back I see that the use of local chests coincided with difficulty over obtaining imported chests. Momis were poor in quality and cost up to Rs. 2·55 in Colombo. It is significant that the use of locally made packages was discontinued as soon as the imported article was up to more normal standards and prices. *Momi* chests for some time now have been costing between 75 cents and 80 cents in Colombo and are good. Can we compete with these? Consideration must also be given to the fact that certain makes of three-ply chests run *momis* close, gauged by their cost per lb. of tea, and that while the supply of *momis* may not be reliable there need never be any difficulty over obtaining three-plys. Bearing this in mind unless careful estimating indicates that they can profitably plant up blocks as a source of supply in competition with outside supplies, the "Powers-that-be" will take a grave responsibility on their shoulders, if they involve the Island in any extensive scheme of reafforestation with the supplying of chest timber as its objective.

The outcome of examination of the question of developing a local chest industry appears to indicate that this is of a major importance only as it relates to the future, namely, the planting up of large blocks of forest with suitable trees and with such that are reasonably rapid growers. These blocks must be located so that transport of the logs to where mills can be sited will be economical.

Our entomologists will, before anything can be done, have to decide what species, if any, can be brought together in this way without undue risk of borer and termite damage.

The position is essentially a business one and as it takes a cubic foot of wood to make a chest, it will be appreciated that afforestation will have to be on a big scale, if the scheme is to play an appreciable part in the business of coping with requirements.

Only if it is possible to produce the article at a figure, which will insure ability to sell in competition with imported chests can the supplying of chests for packing purposes come into consideration in connection with afforestation and we must look to forestry and business experts to advise us upon this problem.

RUBBER TAPPING EXPERIMENTS, HENERATGODA

THE account given herein completes the experiments to test the relative value in yield of rubber from tappings on $\frac{1}{4}$, $\frac{1}{3}$ and $\frac{1}{2}$ circumferences. Previous accounts were given in this Journal of August 1925 and August 1926.

The progeny of No. 2 H. tree has been under test at Heneratgoda for the past nine years, and the results of the experimental tapping which is now completed are presented. The object was to test the relative values in yield of rubber from tappings on $\frac{1}{4}$, $\frac{1}{3}$ and $\frac{1}{2}$ circumference. Sixty trees were divided into three groups of twenty each. The system of tapping adopted was a single cut to the left at an angle of 16° starting at its lowest point at a height of 2 feet from the ground. The groups were tapped on a different bark area during each three-year period, as follows, in order to consume the whole circumference at the conclusion of the experiment:

	1st period 1923-1926	2nd period 1926-1929	3rd period 1929-1932
Group I	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{1}{4}$
Group II	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{3}$
Group III	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$

It is to be noted that previous experiments showed the yields from individual trees varied considerably and due to this the yields of the groups themselves varied apart from variance due to area of tapping panel.

Tree No. 61 in Group III was lost in a gale in June 1926, and in order to render the yields of the respective groups comparable, those of Group I and II and of Group III for the first period have been calculated for 19 trees based on the mean yield per tree.

The girth measurements and number of latex vessel rows of the trees tested are shown in the following statement:

GIRTH MEASUREMENTS AND LATEX VESSEL ROWS OF THE TREES IN THE GROUPS

(All trees are the Progeny of No. 2 H)

No. of Tree Group I	Girth at 3 ft. Ins.	Mean No. of Latex Vessel Rows.	No. of Tree Group II	Girth at 3 ft. Ins.	Mean No. of Latex Vessel Rows.	No. of Tree Group III	Girth at 3 ft. Ins.	Mean No. of Latex Vessel Rows.
1	37	17·7	30	50	16·7	59	42	18·7
2	48	24·7	31	51	20·7	61	44½	—
3	42	19·3	33	33½	13·3	63	38½	11·7
4	37	13·0	34	36½	16·0	66	38½	11·0
5	40	15·7	35	43½	26·7	69	50	14·7
6	45½	25·0	36	44	17·7	70	42	12·7
7	52	13·3	38	38½	15·7	71	49½	14·7
8	33½	14·7	40	33	11·7	72	44½	20·7
10	47¼	16·3	41	43½	9·3	74	38½	13·7
12	53½	14·7	42	38½	17·7	75	41	17·3
13	54½	12·0	43	50	25·0	76	48½	10·0
14	42¾	12·3	44	42	18·3	78	45	12·0
18	36	15·7	46	40½	16·0	81	51	20·0
21	38	16·7	48	46	25·0	83	54	16·3
22	39	16·3	49	46½	19·3	90	48	11·3
23	35½	15·7	50	37	13·7	91	44	15·7
24	47½	23·7	51	40	16·0	95	41	14·3
25	43	17·0	52	51½	19·7	97	39	15·7
26	40½	16·7	54	30½	18·3	98	40½	13·0
29	38	15·3	55	32	17·0	100	51	8·0

The following is a summary of the total yields (biscuit and scrap) in grammes calculated for 19 trees in each group:

	Tapping area	Group I	Group II	Group III
		⅓	½	¼
Ist Period	Total yield	105,922	135,996	79,441
1923-1926	Mean per tree	5574·8	7175·7	4181·2
	tapping area	½	¼	⅓
2nd Period	total yield	186,944	116,838	156,746
1926-1929	mean per tree	9839·1	6149·3	8249·7
	tapping area	¼	⅓	½
3rd Period	total yield	122,595	171,497	251,667
1929-32	mean per tree	6452·3	9026·2	13,245·6
Whole period (9 years)				
Total yield of each group		415,459	424,332	487,854
Mean yield per tree		21,866·3	22,333·2	25,623·8

The yields from the different systems of tapping are summarised as follows:

Total yield	$\frac{1}{4}$ area	Ratio	$\frac{1}{3}$ area	Ratio	$\frac{1}{2}$ area	Ratio
1st Period	79,441	100	105,922	133·3	135,996	171·1
2nd Period	116,838	100	156,746	134·1	186,944	160·0
3rd Period	122,595	100	171,497	139·8	251,667	205·2
Total	318,874		434,165		574,607	
Ratio	100	:	136·1	:	180·1	

The ratios from other countries, published in the issue of this Journal for August 1926 were:

	$\frac{1}{4}$	:	$\frac{1}{3}$	:	$\frac{1}{2}$
Malaya	100	:	121	:	143
Sumatra	100	:	125	:	150
Java	100	:	117·5	:	145

In the case of Malaya and Sumatra the yields from $\frac{1}{2}$ circumference were from V-cuts.

The yield ratios in the same group for different periods show considerable fluctuation:

	$\frac{1}{4}$	:	$\frac{1}{3}$	:	$\frac{1}{2}$
Group I	(3rd period) 100	:	(1st period) 86·4	:	(2nd period) 152·4
Group II	(2nd period) 100	:	(3rd period) 146·7	:	(1st period) 116·3
Group III	(1st period) 100	:	(2nd period) 197·4	:	(3rd period) 316·7

The percentage of scrap to total yield in each of the groups for the different tapping systems was as follows:

	$\frac{1}{4}$ area	$\frac{1}{3}$ area	$\frac{1}{2}$ area	Mean
	%	%	%	%
Group I	10·9	9·4	9·2	9·7
Group II	16·7	12·5	14·0	14·1
Group III	12·1	10·2	9·2	10·0
Mean	13·2	10·7	10·8	

The results were affected by the particularly high out-turn of scrap of two trees, Nos. 30 and 44 in group II in all the three periods.

TROPICAL PLANT DISEASES: THEIR IMPORTANCE AND CONTROL*

IN the great tropical and sub-tropical plantation industries, such as tea, rubber, coffee, cocoa, citrus fruits, etc., large areas of permanent crops are cultivated on capitalistic lines with uniform and usually white control. On an estate of hundreds or even thousands of acres, often under highly intelligent supervision and where the produce may be worth a great deal of money, it is comparatively easy to get adopted improvements which are the results of scientific research, whether in the control of disease or in any other direction. It is quite a different matter, however, when one comes to deal with the crops grown by the indigenous people of the tropics for their own use. Their agricultural practices are rigidly traditional, their standard of intelligence may be low, money is scarce or even absent, and their crops are raised in small-holdings, often subdivided to an almost incredible degree. I once had occasion to acquire 17 acres for expansion of an agricultural research station in India and found 30 families and 91 individual plots represented in this piece of arable land. In such conditions—and they are those under which a great part of the population of the world lives—"the cultivator's ways and the sheep's ways tend to be much the same," as an Indian proverb says and however well the traditional agricultural methods are followed, the cultivator is apt to be helpless in an emergency, as, for example, an outbreak of epidemic plant disease.

It is not surprising that the earlier plant pathologist who worked in the tropics, from the time when Marshall Ward went to Ceylon in 1880 to fight coffee leaf disease, when it was already too late to save the industry from ruin, should have concerned themselves mainly with the diseases of the great export crops. A study of the reports of fifteen or twenty years ago will show that for practical purposes, India was the only tropical British possession in which it was the policy of the agricultural departments to devote much of their attention to the crops grown by the people of the country for their own use. During the past ten years, however, there has been a considerable improvement in this respect in the British Colonies, especially those of tropical Africa. Most of the colonies have one, and a few have two, plant pathologists attached to the agricultural departments and where as in several of them there are no plantation crops, the needs of the village cultivators are receiving attention. Even in some of the more advanced 'plantation' colonies such as Ceylon and Malaya, the large plantation industries have now organised their own research departments, leaving the Government departments of agriculture free to concentrate on the improvement of the local crops and methods of farming.

Such improvements are likely to increase the responsibilities of the plant pathologists. New and improved varieties of crop plants are liable to become attacked by diseases from which the old ones had become

* By Dr. E. J. Butler, C.M.G., C.I.E., F.R.S. in *Nature*, No. 3295, Vol. 130.

immune through age-long selection, and more intensive methods of farming often have a similar result. The great activity in crop improvement that has been characteristic of agricultural development in the United States and Canada since the beginning of the present century, has been accompanied by such an increased call on the services of plant pathologists that each of the staple crops has, not one but many, men engaged in the study of the cause and control of the diseases to which it is liable. As similar efforts are made to improve the staple food crops of the tropics similar needs will be felt. There are clear indications from the work on rice in Japan that even in a crop such as this, which in India is one of the healthiest of all the field crops, there is a number of diseases capable of becoming formidable obstacles to the introduction of improved varieties.

The two tropical cereals next in importance as food crops, sorghum and the bulrush millet, are much more subject to disease than rice, but very little work has been done on them in the tropics and even the full life-history of several of the common bulrush millet parasites is unknown. Still less is known of the diseases of the tropical pulses and other plants of economic importance, except those that are grown for export. Tropical plant pathology has not much to boast of in the study and control of village and field crop diseases; the number of man-years of work put into this branch of agricultural science is too small to have yielded much result and the difficulty of getting the native cultivator to change his ways, as well as his lack of means and general backwardness, has helped to induce a pessimistic outlook amongst those who are charged with the control of agricultural research and amongst the research workers themselves. Nevertheless, not only because there is great preventable loss of crops from disease in the tropics but also because a solid knowledge of the pathology of each crop plant is a necessary concomitant of all attempts at crop improvement, means must be found to surmount these difficulties. Little by little, openings for successful attack on them will appear, and however slow progress may be at first, the next fifty years are bound to see a great improvement in the crops and in the general agriculture of even the most primitive of the African Colonies. In this advance plant pathologists will have to bear an ever increasing share.

The work which has been done in India during the past twenty-five years or so illustrates some of the problems that the tropical pathologist has to face in dealing with village and field crops. When the Indian agricultural department was formed thirty years ago, extremely little was known of the diseases of tropical plants, though there were a few exceptions, such as sugar cane. The first work done in the mycological branch, therefore, was to make a survey of the diseases of the more important crops, and when many of these were found to be undescribed, a more intensive study of a few was undertaken and lasted a number of years. Two of them, one on palmyra and coconut palms and the other on rice, broke out in epidemic form and had to be dealt with on emergency lines, invoking the aid of the administrative services and leading, in the palm disease campaign, to legislation of the kind that is familiar in more advanced countries, where it becomes an actionable offence to own a diseased plant without reporting or dealing with it as prescribed. In the campaign against this disease, which was exterminating the palmyra in an area where this was the dominant tree and by far the most useful, nearly a million diseased

palms were cut out to save the rest. This and the subsequent legislative action and the discovery that many trees could be saved by removing the bud sheaths in the early stages of attack have been successful in preventing the spread of the disease and in keeping it within manageable proportions. The campaign cost the Government about £20,000; but the value of the palms cured by treatment was estimated at about £28,000 in 1921, and the number saved from infection must run into millions.

In other cases it soon became evident that the variety of the crop grown was exceptionally liable to disease either because of inherent susceptibility or because disease had been allowed to accumulate in the stock and was being transmitted when diseased material was used for planting each successive crop. In such cases the agriculturists of the department, each of whom had a district under his charge, became invaluable collaborators, both in observing the injury done to particular varieties and in introducing new or more healthy ones.

Then there were the cases where one had to make a direct attack on the parasite and try to kill it or to prevent its spores germinating by the use of fungicides. This at once brought one face to face with the economic limitations of village agriculture in countries like India, where the cultivator usually has little actual money at his disposal and can only borrow at exorbitant rates of interest.

Copper and sulphur have remained to the present day the chief weapons in the hands of the plant pathologists in their direct attack on fungal parasites. In India they have been used chiefly on the more valuable orchard and garden crops or as seed disinfectants on field crops.

The relative infrequence of destructive epidemics of disease amongst indigenous crops in the tropics as compared with the great plantation crops is not due, I think, as is sometimes assumed to the circumstance that the latter generally occupy larger continuous areas under the one crop, so that disease germs can multiply and infect more readily. In India there are large areas of village lands mainly under a single crop, as rice in 70 per cent. of the cultivated land in parts of Bengal or cotton in 60 per cent. of Khandesh. Freedom from disease in these cases is probably mainly due to disease resistance having become, through long experience, the determining factor in the selection of the varieties grown, the quality of which is liable to be a secondary consideration and is often decidedly low. In the plantation industries, on the other hand, quality which will enable the produce to compete in the markets of the world is so important that hardiness may be sacrificed. Examples of destructive epidemics in these crops are numerous and are not, as in the other category, usually due to newly introduced parasites. They are just as often due to an old parasite finding in a new variety a congenial host. They are sometimes also due to the considerable financial return leading to expansion of a plantation system into areas not naturally affording optimum conditions for the growth of the plant, so that its environment may become more favourable to the parasite than the host.

The recent wave of epidemic disease that has ravaged the cotton plantations of the Sudan may perhaps find a partial explanation in these considerations. When the great Gezira irrigation scheme, due in its inception to the genius of Garstin and Kitchener, was opened in 1925, it was

already established that the highest quality Egyptian long-stapled cotton could be successfully grown in this previously arid waste. At the present time, approximately 200,000 acres of irrigated Sakel cotton is grown as the major crop in the gigantic plantation of 600,000 acres under uniform control and cropping, surely the largest arable farm in existence. During the first five years after the dam was built across the Blue Nile, cotton worth more than £12,000,000 was produced from the Gezira, and 150,000 people had settled where before there was only a scattered famine stricken population.

The cotton disease known as blackarm occurs in all the cotton-growing parts of Africa, but it seldom causes much injury to the varieties grown by the people of the tropical regions, and the long-stapled kinds grown in Egypt escape damage apparently because the climate of Egypt does not suit the parasite. In the Egyptian varieties grown in the Sudan it became a formidable pest, being one of the main factors in reducing the yield per acre from 479 lb. in 1925-26 to 129 lb. in 1930-31. This represents a loss of more than 60,000,000 lb. of cotton on the area grown in the latter year, worth even at the low prices then prevailing, more than £800,000. As the disease is carried mainly on the seed, an elaborate scheme of seed disinfection with the dust known as 'Abavit B' was carried through before the last season's crop was sown, the whole of the seed for this great area, representing more than 30,000 bags, being treated by specially devised seed dusters. Various other steps were also taken to combat the disease, and the yield, when harvest was completed last spring, was found to have risen again to a little more than 400 lb. per acre, or not far short of that of the earlier years.

In this case there is far more at stake than the saving of an industry, however important. The whole future of a province is in the balance. I cannot refrain from quoting a foreign observer who visited the Sudan two or three years ago. "The Sudan is the latest thing in European exploitation and it is the best." There has been "created a corps of agriculturists and entomologists to destroy the pests that attack the native crops; a group of veterinarians to look after and improve the native cattle; and a quite unrivalled body of biologists, bacteriologists, laboratory workers and doctors to fight native diseases. Trekking through the land are the Government biologists and entomologists, experimenting, destroying pests, noting processes, giving advice. You rarely find them in the same place for two weeks running; these hardy scientists do even more work in the open than in their laboratories."

The West Indies present a very different picture from the Sudan. There, in some of the oldest of the British Colonies, generations of planters and settlers have been engaged in the tropical and sub-tropical cultivations of lands favoured by Nature to an unusual degree. Jamaica is the largest banana exporter of the British Colonies, having sent out 24,000,000 bunches in 1930, representing more than 50 per cent. of the total value of her exports. In 1912 the first cases of the now notorious Panama disease of bananas in the island were examined by S. F. Ashby. Rigid quarantine measures were promptly introduced by the Director of Agriculture, Mr. H. H. Cousins, impressed by the ruin from this disease which had befallen the banana-growing enterprise in the Dutch Colony of Surinam between 1906 and 1910. As soon as a diseased plant was discovered, it and

all the surrounding ones on an area of four chains had to be destroyed and the area fenced in. As a result, spread was slow, the number of cases annually not surpassing 1000 until 1921. Increase since has been at the rate of about 50 per cent. a year, until by 1929, there were about 85,000 cases, involving nearly 140,000 plants. In the parish of Portland, the most diseased, some 9,000 acres, or approximately one-tenth of the total estimated banana acreage of the island, have now been abandoned, for it has been found that commercial banana growing is impossible on land once infected, and the great United Fruit Company has already abandoned nearly 100,000 acres from this cause in Central America. The expenditure by the Government of some £60,000 in Portland no doubt prolonged the life of the plantations by ten years or more, but in the end has proved unavailing.

As there is no direct method of fighting this disease, which is due to a soil fungus, attempts to procure resistant varieties are being energetically carried out both in Jamaica and at the Imperial College of Tropical Agriculture in Trinidad. Varietal tests have shown that the Cavendish species of banana and some others are either highly resistant or totally immune. Botanists both from Kew and the West Indies have toured the world in search of varieties for trial and hybridisation and these are grown under quarantine and inspection at Kew before being sent on to Trinidad. Very large numbers of crosses have been made in Trinidad and Jamaica and some of the immune seedlings produced in the latter island have given bunches which were acceptable to the trade during the past year. The Trinidad seedling I.C.I. (Imperial College No. 1), a cross between the commercial Gros Michel and a wild species, has also shown remarkable immunity during six years' tests, but the fruit still requires improvement.

It is estimated that within the next five to seven years, at the present rate of increase of the disease and the amount of suitable banana land left, the Jamaican export will begin to decline, and the decline is likely to be rapid unless a satisfactory resistant variety can replace the Gros Michel. The breeding work is difficult and slow. It is not easy for the stricken farmers to be patient. The whole population in the coastal parts of the parish of Portland has been brought up to the cultivation of the banana before anything else, and though an alternative crop of marketable value is desperately needed, it will take a long time to break down prejudices in a one-crop population. Many of the people have migrated, but many have remained to make a living as best they can. It is cold comfort to tell them, as there have not been wanting even scientific men to say, that these coastal lands, extraordinarily fertile though they be, are unsuited to the banana because the damp soil favours attack by Panama disease. The local Department of Agriculture has never taken that view but has striven hard to fight the disease, and the extra lease of life that it has given the industry, though insufficient in Portland, may yet save the banana cultivation of the island as a whole.

In the examples selected to illustrate the importance and control of the diseases of tropical plants, there is every gradation in severity from the sorghum smut which levies a moderate toll of about ten per cent. of the crop on some millions of acres in India, to the Panama disease which completely exterminates the susceptible bananas and precludes replanting within any reasonable time. The success of the measures which have been adopted to

control these diseases also shows every gradation from the complete control which is easy to obtain by disinfection against sorghum smut or by growing Cavendish bananas in Panama-diseased land, to mere alleviation which appears to be all one can hope for, but is yet sufficient, against rubber mildew or the root diseases of limes. A consideration of these measures—ruthless eradication, the complete replacement of susceptible varieties, hybridisation or selection to obtain resistant plants, budding or grafting on resisting stocks, modifications in agricultural practices like stubble burning or pre-watering, and, finally, the direct attack on the parasite by steeping, spraying or dusting—indicates how varied is the task of the plant pathologist and how wide must be the foundations of his knowledge if he is to perform it successfully. The old conception of the mycologist, student of the fungi that cause disease, as adequately equipped to fulfil the duties of a plant pathologist, dies hard but it is dying. Like bacteriology in the realm of medicine, pure mycology is a necessary foundation and the mycologist a necessary collaborator, but he is not equipped either as a general practitioner or a specialist in particular diseases.

The practical man is often slow to admit that a destructive disease in a plant is due to agencies outside his control. Confronted with such he is inclined to seek for explanations other than the true one. He looks first for some disorder brought about by cultivation or in breeding, or meteorological phenomena. Or he thinks that the soil is unsuitable or has become exhausted, or that the plant, if an exotic, has failed to become acclimatised. It is often not until all these have been tested and found wanting, that the true cause is fully realised. Experience has shown that it is unfortunately rare to find the explanation of serious disease in these directions and the dominating factor is usually the presence of a parasite, however much its activities may be favoured by secondary causes.

Failure to recognise the very varied weapons used by modern plant pathology and undue weight given to the secondary factors in the causation of disease have led, no doubt, to the suggestion which I have heard that the 'mycologist', as he is still called in most of the British Colonies, may be in danger of losing his position as one of the most essential members of any team of tropical research agriculturists. In actual fact there can be no question that, looked on as a member of a team and relying on the collaboration that must exist between him and the plant breeders and agriculturists, the plant pathologist is more needed now than ever. Improvement in the crops of the people and the quest of quality or the satisfaction of market fancies in the plantation crops can be relied on to be followed by increase in disease. Unless plant pathologists well versed in the pathology of the crop concerned are available—and they cannot be produced at a moment's notice—the examples I have given will be paralleled in every Colony in the British Empire.

GRAZING AS A PROBLEM IN FORESTRY*

THE problem of the limits within which grazing can be allowed without risk to the proper conservation of the forests is very old and up to the present it has rarely been found possible to solve it on purely technical lines. Considerations of a general economic and also social order have almost universally stood in the way of any consistent policy.

It is to be noted further that the degree of seriousness of the effects of grazing vary in accordance with the climate of the various countries.

Thus it is in countries with temperature or hot climates that the risks of grazing are most marked on account of the special difficulties inherent in forest regeneration, while it is precisely in such countries that the constant extension of the cultivation of important crops on the fertile plain lands causes pasturing to be increasingly diverted to the mountains and to higher ground where the forests are to be found.

In countries with a cold or damp climate, pasturing seems to have been developed as regards the use of plain or mountain areas with a better sense of proportion. Where the conditions for forest regeneration are most satisfactory and just consideration is given to the chief factors, including nature of the stock, age of stands, duration of the period of grazing on the same area and, more particularly, the careful assessment of the grazing capacity of each unit of area, a genuine effort has been made to reconcile the interests both of the grazing and of the forest industries. In such cases stock-raising requirements seem to be mainly supplied by local resources apart from the forests and it is possible to make any particular adjustments that may be necessary.

It is a quite different matter in regions where pasturing from its beginning is made to depend almost entirely upon the forests. In such conditions the constant increase of grazing might well bring about a complete destruction of the forests of the district and at the same time economic disaster for the inhabitants.

These phenomena have characterised all stages of history and the regeneration of forest areas which have suffered from excessive grazing has in the past encountered all kinds of difficulties as it does still to-day. At the same time it appears that any action on the part of experts and of public authorities frequently meets with local resistance in various forms and often springing from ancient usages.

A careful analysis of the different kinds of mischief caused by forest grazing would in most cases fully justify the strictest limitation of the extent to which pasturage can be admitted at all.

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* From *International Review of Agriculture*, International Institute of Agriculture; Year XXIII, No. 10, October, 1932. Compiled by S. Cabianca.

Observers are as a rule particularly concerned with the direct damage caused by grazing, although recently there has been a growing tendency to pay attention to its indirect results which constitute the real danger.

Indirect damage begins with the forest soil itself. It mainly originated in the trampling of the animals, the effects being by no means always in proportion to their size or weight, each kind behaving in its own way as it passes from one place to another. The number of wanderings during the same period and over any given area varies with the degree of energy of the particular kind of animal and the footmarks of the different species affect differently even in the same forest surface according to the lightness or the reverse of the tread in each case.

The frequent passage of animals over the surface has effects which vary according to the degree of the gradient. The geological character and the mineral basis of soils, through their influence on the soil-making qualities of the surface layers, are also of importance and in certain cases make it absolutely necessary to prohibit grazing altogether.

The goat for instance is a voracious feeder but does not stay for any long time in any one place, even if it provides abundance of food. A goat's hoof presses heavily on the surface in which it leaves deep holes; at the same time the goat moves about very quickly and constantly returns to the same spot. Thus it comes about that goat trampling nearly always leads to serious results particularly as a goat is able to stand upright on the most difficult ground.

On the other hand the ways of sheep are quite different. They seem to prefer to browse for a long time in the same place and as a rule the mischief they cause to the surface appears to be less serious than that brought about by goats.

Cattle require a large amount of fodder every day and therefore they are as a rule obliged to look for somewhat extensive pasture areas. The results of cattle grazing are ordinarily not very serious for forest soils, except where the ground slopes steeply.

A. H. Unwin (Great Britain) has described the results of goat trampling in its relation to the mineralogical character and the stage of the evolution of the soil of wooded surfaces which are grazed by goats. He calls attention to the fact that, where the slope is strongly marked, the soil layer is usualy thin and can only be properly maintained through a quite regular, gradual and slow drainage of the rain water. Goat grazing on such soils affects the soil layers immediately below the loose surface and close to the bedrock, and in these circumstances there is no possibility of any resilient reaction at the lower level. Thus the disturbance of the surface will have effects of a more or less immediate character which it will be a very difficult matter to remedy. Sooner or later the soil will suffer from the consequences of accelerated erosion, the first of which will be a diminution of the general power of resistance of the stands to external risks and the process of natural regeneration will be to an increasing degree impeded. Thus should a forest fire occur the general conditions for the conservation of the forest growth on the grazed-over areas will be rendered particularly unfavourable.

R. B. Miller (United States) has carried out grazing experiments over a defined area of forest land. For this purpose he took two acres of loblolly pine (*Pinus Taeda* L.) forest in full vitality and the result of natural sowing, which he divided into four lots. The surface of the first was burnt over and then browsed for five years by small stock. The second was suitably browsed but not burnt over. The third was burnt over lightly each year but not browsed. The remaining parcel was used as a control and neither burnt over nor browsed. Care was exercised to select a place where growth was uniform and abundant, and where regularly spaced mother-trees gave adequate shelter. The results of the trials were as follows: all reproduction growth was stopped on the first lot where two loblolly seedlings only remained, having escaped from the effects of browsing in consequence of their rapid growth; on the second plot most of the seedlings had disappeared and those which remained were seriously damaged; on the third plot the annual burnings had no direct effect on reproduction, though upward growth of the young trees was retarded, the yellow pines (*Pinus Echinata* Mill.) alone shewing themselves unable to withstand the effects of the fire. The fourth lot showed no signs of damage and light burnings made after the fifth year of the experiment, which was the seventh after the original sowing, were also innocuous even to the yellow pines, of which a small number were intermingled with the predominant variety.

N. G. Pring, a British Forest Officer in the Punjab has made certain experiments in connection with the damage caused by sheep turned out to pasture in the forests. After reviewing the results of allowing sheep to browse on young cedar and fir, he was in a position to say that the damage caused to the trees was almost imperceptible. On one reproduction plot of 2 years' old fir saplings no harm at all had been experienced after two consecutive years of pasturing, while at the same time the effects of trampling were also hardly noticeable on account of the abundant soil covering with grass and scrub (*Spiraea Lindleyana*, *Salvia glutinosa*). He however also states that, even if sheep grazing is not prejudicial as regards conifers, it is harmful for broad-leaved varieties so that the first named may be regarded as protected at the expense of the second. At the same time in the conditions prevailing in many parts of the Punjab, leave to graze sheep at times when normal pasturing is difficult is a great boon to the inhabitants of the wooded areas, and it might be possible through a regular system of sheep grazing considerably to diminish fire risks through the establishment of fire lines.

C. G. Trevor, himself also a member of the Indian Forest Service, is not entirely in agreement with these views and is of opinion that a *chir* pine (*Pinus longifolia*) district does not supply good winter grazing for sheep, which prefer open pastures with abundant fine grass. If they are introduced into forest lands, when driven by hunger, they will browse shrubs in the same way as goats and the kind of grass which is useful for cattle is quite unsuitable for flocks. He feels too that as regards the risks of forest grazing, it is a great mistake to be over dogmatic.

In certain cases grazing may inhibit reproduction altogether, in others it does no harm and natural regeneration proceeds normally. In all cases the amount of grazing that can be borne by the unit of forest area must be carefully considered. The whole question is one of degree and, if grazing

is practised to excess, even the best upland and mountain pastures may be ruined. In British India, this fact is confirmed by the plot experiments made by the Forest Research Institute under the direction of Professor Troop and the writer here quoted.

Apart from the opinions to which reference has been made above which are the result of recent experiments and observations, mention may be made of a historic case of a general character described by M. Béky of Hungary. After stating that on the cultivated plain of Hungary there appears to be always an insufficiency of pasturage, he calls particular attention to the fact that in order to remedy this state of affairs, recourse has been had to seasonal pasturing on the cultivated area during the following period and that thereby the general fertility of the lands grazed has been seriously prejudiced. According to M. Béky the results on the soil of trampling by herds and flocks for even so short a period as a month can only be made good by a complete repose for at least three years. Trampling on the afforested lands is even more serious as it cannot be remedied by ploughing or manurings. As a rule the reduction of forest growth through the effects of grazing and the consequent retarding or deterioration of reproduction represent a financial loss which is higher than the returns obtained by the stock farmers.

During the first half of the 19th century at the time of the abolition of feudal rights, a division of the land was made in favour of the class formerly liable to forced labour (la corvée), when it was arranged that each parcel of fertile agricultural land should have a corresponding area of less valuable land for pasture and of poor land for forestry, the maintenance of the forests on the last named areas being made compulsory. In the course of time excessive grazing almost entirely ruined the pasture lands while the lower quality soils, set apart for forestry, gradually became enriched. There is today a movement to establish forest on the worn out pastures and facilities for this purpose are being sought, but it seems unlikely that the support of the authorities will be forthcoming owing to the expense involved and the dubious prospects of success.

State intervention, with the object of the prevention of damage by excessive grazing, is generally found to date back to quite early times but it has rarely given completely satisfactory results. Inasmuch as the facilities for grazing on forest lands must necessarily be on a small scale and kept within fixed limits, it was practically inevitable that there should be great difficulty in maintaining consistent management schemes because of the need for allowing freedom for progressive local development in stock breeding, either on account of the growth of the population or of other economic factors. Hence in most cases the principle of using forest lands regularly in connection with stock breeding is in practice very dangerous.

At the present time there is a distant tendency towards a more accurate determination of certain general rules. Grazing is now increasingly being prohibited in national and protection forests; at the same time in most countries the use of forests belonging to institutions or to private individuals is being properly regulated with special regard to the maintenance of conditions favourable to sound forest regeneration. Efforts are also being made to increase the fertility and capacity of the pasture

lands already in use apart from forest lands by improvements in methods of cultivation and in actual grazing technique, so as to make up the cattle breeders for the disturbance caused by the wide scale application of the systematic regulation of grazing facilities.

It is generally recognised that goat grazing in forests is fraught with such disastrous consequences as to make it desirable to oppose as strongly as possible any further increase of the practice. It has become increasingly clear that economically goat breeding gives negative results, while at the same time in recent years the increase in their numbers in all parts of the world is beginning to assume alarming proportions.

Prof. Agostini (Italy) after examining a wide range of documents, has been able to construct statistics for the increase of the number of goats in most of the inhabited areas of the world. His investigations shew that, on the 100 millions of square kilometres for which his information was available, there were 177 millions of goats and 600 millions of sheep. During the last 20 years about half the world showed a general increase which may be estimated to amount to 13·3 per cent. for goats and 8·8 per cent. for sheep. In his opinion, if figures could be obtained for the world as a whole, the increase, in relation to the growth of population, would be much higher for goats than for sheep.

In the matter of the numbers of goats per square kilometre in the different continents, it may be stated that Asia heads the list with 6·8; then follows Europe (excluding the Europe-in-Asia area of the U.S.S.R. and Turkey) with 4·5; the corresponding figure for Africa is 2·2, for South America 0·8, for North and Central America 0·5, while for Oceania the figure is almost inappreciable, being less than 0·1.

The percentage of these variations at the end of the period considered and according to continents is the following: Europe + 19·4 per cent.—Asia + 19·6 per cent.—Africa + 9·2 per cent.—America (North and Central) + 79·2 per cent.—South America—24·8 per cent.—Oceania—25·8 per cent. In Europe the increase is most marked in the U.S.S.R., followed by a group containing Germany, Greece, Italy and Spain while the increase in Bulgaria, Czecho-Slovakia, France, Norway, Portugal and Yugoslavia are less important. In the other continents the chief variations are to be found in the following countries in order of importance: as regards increases, British India, Mexico and Morocco; as regards diminutions, Brazil, the Union of South Africa and the Lesser Antilles.

No precise information as to the causes of these variations is available, but in general it may be considered that they are closely connected with a certain weakening of control very generally manifested to a greater or less degree during the war as also to the high prices obtainable for certain of the products of stock breeding.

As regards remedial policies, one cardinal point must be constantly borne in mind, namely that the basic needs of the inhabitants of grazing areas must be safeguarded though every care must be taken to avoid anti-economic methods.

In France the principles that find favour may be thus summarised. Grazing in the forest areas should be regarded as permissible as a benefit for the inhabitants, but it cannot be allowed that beneficiaries of this order

should make a business out of such grazing. The inhabitants should be considered simply as having a usufruct in forest products and no exception to this rule should be allowed, since if they were perfectly free they might thereby gain certain temporary advantages at the expense of the general well-being and of a just balance in the economic life of the locality.

In Italy the recent alarming development of goat breeding is absolutely contrary to the pressing need for the protection of mountain soils against erosion. In practice any further development of goat grazing in the forests or on the areas under protective bush growths would nullify the special efforts that have been made to protect the mountain soils, whether by improving the quality of the trees or by regeneration through replanting. The improvement of the mountain uplands, which is generously aided by the State, tends to make good the disturbance in pasturing work which is likely to arise when the forests are relieved of a very risky easement. A special tax is payable on goats grazed on areas where such grazing has been duly authorised.

In Austria, Germany and Switzerland, countries in which climatic conditions make it generally possible to carry on stock raising outside the forest areas, the difficulties encountered elsewhere are not seriously felt and forest grazing is well controlled. In these countries the forest officers' policy, which has the support of public opinion, is favourable to the exclusion of human beings and animals from the forests. Quite exceptionally permission is given to graze goats, on strictly limited scale and at certain seasons, in old oak and beech forests.

In Rumania the time does not seem to be as yet ripe for any radical policy of an industrialised forestry system properly freed from grazing servitudes. The practice of burning afforested or bush lands in order to increase the grazing area still persists. On the other hand the grazing of sheep and goats in the State forests is strictly prohibited.

The injurious results of forest grazing are still very obvious and widespread in Greece, where however the forestry service and the more intelligent public are definitely in favour of the reconstitution and preservation of the forests on the ground that they are a more important economic factor than grazing. Unfortunately however the prevailing conditions of economic life in the mountain areas make any wide application of the general principle extremely difficult.

Forest grazing is in the United States considered as an exceptional means of aiding the stock breeding industry to overcome temporary difficulties. Studies of each type of forest have been made with the object of determining its capacity to tolerate grazing at different ages, and the National Forests are carefully protected. In the States forest fires are more feared than the results of grazing but, thanks to the methods adopted for determining the degree to which different types of forest growths can tolerate grazing, it is always possible to regulate grazing restrictions as regards areas that have been burnt over. In this country there is a clear tendency, in dealing with the problems of the protection of the forest against external risks, to rely after adequate experimental work, on scientific principles duly tested in practice before they are given any general application.

In countries with dry climates, where the type of vegetation gives the soil poor protection against drought, it is generally believed that grazing the forests should be absolutely forbidden. The experience of a number of Dominions and Colonies shows however that the regulation of free pasturing is not a practical possibility and hence, where conditions are favourable, the establishment of definite pasture lands outside the forests is recommended as it is only by such indirect methods that any solution of the problem can be found. In British India, Algeria, Macedonia and Cyprus a fair amount of progress has been made by organising grazing facilities as far as possible outside the forests.

Ribbentrop, of the Indian Forest Service, states that British Forest Officers in India have to encounter difficulties far more serious than their colleagues in Europe. From time immemorial the natives have been accustomed to graze their cattle, sheep and even goats wherever they pleased on all waste lands and forests. Efforts were made in the first instance gradually to effect a change in these habits so as to bring about an accommodation between the acknowledged needs of the native population and the no less urgent call to protect the forest areas, as it is in the best interest of the State to utilise its forest resources to the utmost of their capacity. There can be no justification for leaving the forest to the mercy of forms of exploitation orginating in local customs, which cannot in the long run tend to the betterment of the standard of living of the population. On the other hand special care must be taken to secure the regeneration and restoration of the forest areas that have suffered severely from continuous and excessive grazing. Stock raising can be successfully developed without any undue interference with the forests.

From the above considerations it may be gathered that the most practical methods of checking the further spread of forest grazing lies in the prevention of the permanent use of the woods as auxiliary pasturage, which is better provided by the soils naturally adapted to the purpose. Where the development of stock raising is of special importance, it is the wiser policy to sacrifice certain wooded areas rather than to have recourse to any hazardous form of compromise. Hence the principles that have been enunciated are by no means intended to impose checks on the stock breeding industry, which is likely to find its best chances of success in the careful choice of types of stock specially adapted to local conditions and in the cultivation methods required for the maintenance or for the increase of the yield capacity of lands solely given over to stock raising.

In a large number of countries the serious consequences of the grazing that has taken place in the past, which now make it necessary to reconstitute the forests affected, calls for immediate attention. Hence it is necessary to bring the public to realise that, as forest protection is a duty incumbent on all States, the authorities should be able to rely on their assistance to this end, instead of remaining content with maintaining practices that are not really advantageous in the long run and are far from being in accord with economic principles as understood at the present time.

Any system that makes for delay in restoring the forests, first damaged by grazing and later by fires and erosion, tends to reduce them to a condition of degeneration that may well become irremediable and fatal.

MAIZE—THE KING OF FODDER CROPS*

THE maize plant has been prescribed by Henry as "The Imperial Agricultural Plant of America", and in that country it is certainly the "King of Fodder Plants."

Under suitable conditions and when sown thinly a heavy crop of grain is produced, and when sown thickly little grain is produced but a heavy yield of succulent fodder is obtained, and this can be made into bright and nutritious but coarse hay or the best of silage. Even the stalks from which the grain has been removed have a feeding value of about one-third of the total food value of the whole crop at the time of removal. The stalks from which the cobs have been removed are known as "Stover" in distinction to "Fodder" maize, which applies to the stalks either green or dry, and from which the grain, if they carry any, has not been removed.

In the Dairy Belt there is ample room and need for rapid expansion of the cultivation of the maize plant as summer fodder. This is specially valuable, for it provides the means by which the dairy farmer can ensure adequate supplies of succulent fodder during the dry summer months, and further, it is complementary to the clover hay which can be so readily produced and conserved. On non-irrigated land it is reasonable to expect, with good cultivation, from 9 to 15 tons per acre. In the crop competitions conducted by the Department of Agriculture on such land the yields of fodder maize ranged up to 19½ tons per acre. Fodder maize, by supplementing the grazing on established pastures during the summer months, provides a means whereby progressive dairy farmers may increase the carrying capacity of their holdings.

The whole of the plant is useful for stock food—no part except the roots need be wasted. It can be used at any stage of its growth, but supplies the maximum amount of food material when almost mature: at this stage it furnishes a very large quantity of greenstuff suitable for the bulky part of the ration for dairy cattle or idle animals.

The maize grain when ripe furnishes a concentrated stock food, hard, rich in starch and oil for producing heat and energy, and therefore admirably suited for hard-working animals, especially in winter. The grain is comparatively low in protein and ash, and is therefore not suitable for feeding alone to young animals and milking cows; if it is to be used for this purpose it requires to be mixed or balanced with foods which in protein like clover, lucerne, linseed cake or bran. Broadly, there are three colour types of grain, viz. *Yellow*, *Red* and *White*. This difference in colour may on occasion have an important bearing upon the nutritive value of the respective types on account of their vitamin content. All types are fairly rich in vitamin B, but coloured maize grain contains in addition the vitamin A.

* By Geo. L. Sutton, Director of Agriculture, in the Journal of the Department of Agriculture, Western Australia, Vol. 9, No. 3., September, 1932.

It is essential, therefore, that animals which are being fed on white maize should also receive as part of their ration some food containing vitamin A, as milk, lucerne hay, or green fodder, or pasture of some kind.

The maize plant is botanically known as Zea mays—hence the common name "maize" by which it is known in this State. It is a native of the warmer parts of Central America, and in that country is usually referred to as "Corn" just as wheat, the staple grain of Britain is also known as "Corn". To distinguish it from wheat, where there is likely to be some comparison between the two grains, it is called "Indian Corn," the term "Indian" being used because the early American settlers and explorers found the American Indians cultivating this plant, the grain of which was used by them largely as Europeans use wheat.

The maize plant grows to a height of from two to eighteen feet, according to variety and conditions of soil and climate under which it is grown. The stem or stalk has joints or nodes like the straw of wheat and oats, and this when mature has a pithy interior, which is covered with a thin layer of hard glossy material. Broad succulent leaves are found growing along the stem, a single one growing from each joint. The stalk as it reaches maturity ends in what is known as the "tassel", and this is the male portion of the flower. The other portion of the flower is known as the "silk", and consists of a mass of fine silk-like hairs enclosed in a covering known as the "husk" and in which the grains produced are found. The "silk" being located below the "tassel", the pollen of the latter is blown about in the air so as to provide the opportunity for it to fall on the "silks" and if the conditions are favourable these are fertilised. Each silk extends back into the husk and to what will eventually become a grain of "maize" if fully fertilised. The grains when developed are arranged round a cylindrical central portion known as the "core" or "cob", and this with the grains attached is known as an "ear" of maize. A badly fertilised "ear", which has only a few grains on it, is known as a "nubbin".

Varieties.—The number of varieties of maize is almost legion. From the farmers' standpoint they differ mainly in their period of maturity, their vigour as represented by the height of the stalks, and in the colour of their grain—white, red or yellow.

Experience in this State indicates that early maturing varieties have been found to be most suitable for our conditions, and "Hickory King", with white grain, and "Leaming", with yellow grain, are recommended.

Climate and Soil.—The maize plant, being indigenous to the warmer parts of South America, thrives best under warm moist conditions, and, as might be expected, it is killed by frosts. It will resist drought, however, if the ground is in good condition and well cultivated between the plants until the tasselling period. The experience already gained in this State conclusively demonstrates that it can be grown in the Dairy Belt.

The most suitable soil for maize is a deep sandy loam well charged with organic matter, such as is found in alluvial flats along river banks, and at one time it was considered that maize could only be grown profitably on such soils. It has been found, however, that new and improved varieties, e.g., Hickory King, already referred to, will grow on a variety

of soils, and on those which at one time were regarded as quite unsuitable, provided the land is thoroughly prepared, suitably manured, and the soil between the plants properly cultivated during the growing period.

For the production of grain the critical period is the tasselling stage, and favourable weather and abundant moisture at this time are essential for heavy grain crops. In districts with a limited summer rainfall these conditions are ensured by means of irrigation or by the selection of land known as "summer" or "moist" land, and which has subsoil moisture within about one to two feet of the surface.

Preparation of Seed Bed.—Maize is deep rooting; the soil should therefore be deeply prepared; on average soils the depth ploughed should not be less than five inches and may reach eight inches. It should be *thoroughly* done, for no amount of cultivation after the crop is up can compensate for the lack of thorough preparation. If possible the ploughing should be done some time before the planting so as to give the soil opportunities to mellow. This is particularly so in the case of heavy clay lands, which will benefit considerably by being exposed to the action of frost during the winter. After ploughing the ground should be brought to a fine tilth by the use of harrows including the disc-harrow, if necessary, to deal with and pulverise pasture land. If the ground is at all cloddy the lumps will require to be broken with a roller or clod crusher. This latter can be made by bolting three or four two-inch planks about five feet long weatherboard fashion on to bearers. On loose sandy land the roller will be useful for compacting the seed bed.

Planting Period.—The time for planting will depend upon the climate of the district in which the crop is to be grown, as maize will not stand frost. It should therefore be planted late enough to escape late frosts in spring and early enough to miss the early frosts in autumn. In the main part of the Dairy Belt the month of October will be found safe for early planting, and at the Denmark Stud Farm it has been found practical to plant as late as January for maize for silage—the usual planting date for the silage crop being the first week in January. Between these two dates there is a wide range for planting at intervals to secure a succession of green stuff for dairy purposes. It is anticipated, however, that November will be found the most suitable month for the main planting throughout the Dairy Belt.

Seed Selection.—At one time it was thought that grain from the middle of the cob was better for seed purposes than that from the pointed end or "tip", or from the "butt" i.e., the end to which the husk is attached. Numerous experiments however, have shown that, as far as the resulting yield is concerned, it is immaterial from which part of the cob the seed is taken. That from the middle, however, has the advantage that it is more regular in shape and size, and, therefore, more suitable for machine planting.

Seed maize sometimes carries in it the mycelium of a fungus disease known technically as *Fusarium* sp. or *Diplodia* sp. and popularly as the "Seedling Blight" of Maize. It is so-called because its effect is to cause the seedlings to blight or wilt off. Some plants, after being attacked, may survive and reach maturity but they are always weak. Unfortunately,

there is no known method of control which is readily available to local growers for treating the seed, and the only preventive is to secure seed from crops which have not had the disease. Such seed will only be available when growers generally create a demand by asking for it. When non-infected seed is not available, the means to combat this disease are thicker seeding in the row or hill and the maintenance of high soil fertility supplemented by liberal manuring with superphosphate.

Treatment of Seed.—Sometimes birds, e.g., crows are troublesome and follow the drill marks and pull up the seed after it is planted. To prevent this the seed is coated with coal tar by pouring coal tar over the grain at the rate of one pint to the bushel, and then stirring it with a stick until the grains are evenly covered. When covered they are dried for planting by mixing with sand or ashes. Seed disinfection with organic mercury compounds, such as "Bayer dust" and "Improved Semesan Junior", has given good results in controlling many seed-borne diseases in the United States of America, but unfortunately these substances are not at present on the market in this State.

Rate of seeding.—The practice of sowing maize broadcast is almost universal in Western Australia. Such a method is, however, no longer in accordance with modern practice in the Eastern States and the United States of America, and it is desirable that it should be discontinued here, even when intended for fodder purposes only.

Maize intended for grain is planted in either drills or "hills"; under the former method the single plants are grown at regular intervals in rows, under the latter two or more seeds are planted at regular intervals in rows in holes or "hills". It has been found inadvisable to have more than four plants in a "hill", and the common practice is to have three. Experiments have shown that there is little or no difference in the yield whether maize is planted in "hills" or drills.

The "hills" are said to be checked when the hills are in lines across the rows as well as in the rows, just as in many orchards the trees are in lines in two directions, one at right angles to the other. The checked hill method has the advantage of allowing the land to be cultivated two ways, and thus facilitates the destruction of weeds in dirty paddocks. To enable the proposed crops to be planted according to this system, special appliances called "check row" attachments have been devised for use with double-row planters. When a machine-planter with such an attachment is not available, a common plan is to strike out furrows across the length of the paddock, the distance the rows are intended to be and then plough out other furrows running across the width of the paddock, and sow the seed (say four grains) where the furrows intersect one another.

Great variation has been obtained in America and Eastern Australia with regard to the number of plants to the acre, and has ranged almost all the way from 5,000 to 50,000 per acre. The drills have varied from three to five feet apart with single grains one and a quarter to four feet apart in them. The closer distances usually give the greatest yield of food material, but with smaller cobs and more "nubbins". When the crop is sown for grain the husking of the smaller ears increases the cost of harvesting and so the happy mean between high yield and low cost of husking is sought.

There will always be some variation in the number of plants per acre necessary for best results, on account of the difference in varieties and climate. As the result of many experiments the tendency now, however, is to maintain a uniform distance between the drills about 40 inches and to vary the distance between the plants in the drills. It is believed that under Western Australian conditions maize planted in drills about three and a half feet apart with single plants 12 to 15 inches apart will give best results for grain, and with plants four to six inches apart best results for fodder or silage. At these distances the amount of seed required per acre will be: for fodder or silage, 14 to 18 lb.; for grain, six to eight lb. If planted in "hills" it is recommended that the "hills" be three and a half feet apart each way, with three grains to the hill.

Depth of Plant "Listing."—Maize being a large seed, quite a considerable percentage will grow if planted four and five inches deep, but from two to three inches deep is considered the best depth to sow. It throws out brace or secondary roots as well as primary ones, the object being to resist the effect of heavy winds on such a tall plant. It is considered desirable to have these roots well below the surface and it may be thought this can be accomplished by planting deeply. This, however, is not so, for no matter how deep the planting, the secondary or brace roots will grow just below the surface, whether planted as deep as six inches or as shallow as two inches. To overcome this characteristic the practice of planting the seed two inches deep at the bottom of an open plough furrow, and then to fill in the furrow by successive cultivations as the plant grows, is sometimes adopted. This method is known as "listing". It is claimed by its advocates that a "listed" crop will stand drought better than one planted on the level. Sometimes such a method is necessary during a dry spell in order to reach the moisture necessary for germination. This was the case at the Denmark Farm last season, and as a result it was practically the only crop fit to harvest in the district owing to an abnormally dry summer.

Maize Planting Machine.—Single and double row maize machines for planting are now available. They are expeditious and do extremely satisfactory work. They are designed to sow the seed in "hills" or single grains at regular intervals, and with suitable plates can be used to sow seeds as small as turnip seed or as large as French beans. They are also fitted with an attachment for applying the fertiliser, and with a device for marking out the line for the driver to furrow when planting the next row or rows. These machines open the furrow, drop the seed, cover and press the seed into the soil in one operation. This last operation of pressing the seed into the soil is of considerable importance, and is done by the rear or driving wheel, which has a concave surface. The best machines have what may be described as a "split" covering wheel, that is, the iron rim is in two pieces with a space of about three-quarters of an inch between each side. If the surface of the covering wheel is unbroken all the soil above the seed is compacted or firmed, whereas if there is a space between the two edges the soil immediately above the grain is loose, and does not become badly crusted if rain falls before the seed shows above the ground.

Because of the importance of pressing the seed into the moist soil, to assist germination, hand planted seed should be pressed with the foot as it is dropped.

Single row planters can be drawn easily by one horse, but when the machine is used with the marker on, it runs more smoothly and is less strain on the driver if a pair of light horses are used. About seven acres is a fair day's planting with a single maize planter with drills three and a half feet apart.

Manuring.—Unless it is intended to replace all the plant food removed by the crop, the system of manuring will be governed to some extent by the character of the soil on which it is grown, for under other conditions the farmer will desire to utilise some of the latent fertility of the soil. As a guide to what may be expected in this connection it may be stated that sandy soils are deficient in practically in all the elements of plant food and peaty or swamp soil deficient in the mineral constituents (phosphoric acid and potash), whilst clay soils are usually well supplied with potash.

Because of the large tonnage produced, a crop of fodder maize removes from the soil a very considerable amount of plant food. A 10-ton crop, which is only a fair one, will remove about 80 lb. of nitrogen, 30 lb. of phosphoric acid, and 70 lb. of potash. Of these constituents nitrogen is much the most expensive relative rates per unit being: nitrogen 12/6, phosphoric acid 4/2, potash 7/4. To supply the whole of the quantity of nitrogen required by means of commercial fertilisers is economically impossible. Fortunately it can be supplied indirectly and without cost by sound farming methods, as the result of growing a legume, e.g., subterranean clover, to precede the maize crop, for legumes have the ability to collect and store up this valuable plant food from the free nitrogen present in the air. Subterranean clover is a legume, and grows most luxuriantly throughout the Dairy Belt. It should therefore become an established practice to arrange that the maize crop follows clover pasture after the second or third year though this is not so necessary in peaty soils. When maize is to succeed clover the land should be ploughed up sufficiently early in the winter to enable the clover roots and stubble to become partially decomposed and incorporated with the soil before the maize is planted.

Farmyard manure or any coarse manure can be applied with very great advantage and in any quantity with perfect safety to this crop. There is no danger of heavy dressings injuriously affecting maize, as would be the case if applied to the wheat crop in the Wheat Belt. Nor is there any need to wait until it rots before spreading it on the land intended for maize, for the cultivation which must be given the maize crop will destroy the weeds which may grow from the unrotted manure. It can be spread with advantage on the subterranean clover or legume sod as fast as it is made and ploughed in at convenient times. The maize plant, because it is a gross feeder, can make use of the coarse unrotted manure, and it is assisted in this direction by the fact that it makes most of its growth during the summer when nitrification and other natural agencies are most active, and in consequence a larger proportion of the plant food constituents are made available than would be the case if the crop were grown in the winter.

Because of their usual deficiency in phosphoric acid, it is probable that in all our soils it will be advisable to supplement the application of stable manure, and the plant food accruing from the turning in of the clover sod with an application of superphosphate, and on sandy and peaty swamp soils with some potash.

Pending the securing of definite local information regarding the crop requirements under our conditions of soil and climate, it is recommended that the fertiliser used on clay and alluvial soils which are usually well supplied with potash be 2½ cwt. of superphosphate per acre. On sandy, peaty and swamp soils, which are usually deficient in potash, an addition of ½ cwt. of sulphate or muriate of potash per acre to the superphosphate is also recommended. If the maize be planted on land other than peaty or swamp soil which has not had subterranean clover or other legume preceding it, it will be advisable to add at least a half cwt. of sulphate of ammonia per acre to the above fertilisers. With this latter addition the fertiliser will be of similar composition to the Potato Manure E put up by the fertiliser firms.

The fertiliser can be applied at the time of planting, but as it is risky to have potash fertilisers in direct contact with the young rootlets, provision should be made to prevent this either by stirring the fertiliser into the soil before the seed is planted or by some other method.

Cultivation after Planting.—Much if not the whole of the success which will attend the cultivation over a large part of the Dairy Belt will depend upon the cultivation given to the soil after the crop is planted. A huge crop—up to 20 tons—which the maize plant is capable of producing in a short time, requires a considerable quantity of moisture and plant food. By cultivating the soil between the rows of plants, the weeds which would rob the maize of both moisture and food are destroyed, the moisture is conserved by reducing the loss resulting from evaporation, and the soil is aerated and the natural agencies stimulated to make plant food available. Realising these facts, it can be readily understood how important a part "intertillage"—or cultivation between the drills—plays in the production of this crop, and especially where the summer moisture is limited. It may be advisable to cultivate the soil before the young plants have appeared above the ground, if warm rains have occurred and the weeds are germinating rapidly. Such instances are likely to be rare. Almost invariably, however, it will be found that intertillage is desirable as soon as the rows of plants can be seen, and this should be continued as often as may be necessary to keep down weeds and maintain a loose layer—a "blanket mulch" of earth on the surface.

The cultivation should begin soon after the seed is sown and continue until nearly as high as a man's head. A light spike tooth harrow can be run over the crop until the plants are about six inches high, after which a single horse cultivator, which will go between the rows, or a two-row cultivator, which will straddle the rows should be used. The depth of cultivation should be from two to three inches. Deeper cultivation is likely to injure the roots which grow within a few inches of the surface and soon extend from row to row.

Under most conditions three or four cultivations will be sufficient, though occasionally more will require to be given. A badly prepared seed bed, a heavy growth of weeds, and frequent showers will increase the number necessary for the best results.

For areas up to 10 or 15 acres the single horse hoe or cultivator, is very suitable. This is light to handle, and with practice a smart driver can become so expert as to destroy frequently weeds which may be found growing betwen the individual plants in the drill.

For larger areas than 15 acres a double-row cultivator of the same type, and which will straddle the rows, can be obtained.

Harvesting.—When required for grain the most common practice is to allow the crop to stand in the field until the grain is quite ripe, a condition which is indicated by the husks becoming dry and hanging down. These are then gathered by hand and husked in the field or in the barn.

Unless the grain is quite dry when gathered it should not be stored away with the husks on as it is likely to heat and mould. Until thoroughly dry the cobs can be stored only in open sheds which admit of a free circulation of air.

After the ears are husked and the grain thoroughly dry, they require to have the grain shelled off them. This is done slowly by holding the cob in one hand and forcing the grains off with the thumb and palm of the other hand or by the core of another cob. Shelling is done more expeditiously by maize shelling machines operated by hand or power.

The maize grain is a very concentrated form of food, similar in value to wheat. On account of its hard character it is usually cracked before being fed to stock. It is extremely useful for feeding to farm horses, and has not the same injurious effects as is experienced with wheat. Large quantities are, however, somewhat heating, though in some parts of the Eastern States it is practically the only grain fed to horses which are working hard.

For the best results, as a concentrate for milking cows, it requires to be mixed with some more nitrogenous food, such as peas.

For pig raising, the twin ally of milk production, maize grain ranks very highly and is complementary to the separated skim milk left on the dairy farm, as this is rich in proteins and ash, and in consequence balances the maize which is rich in carbohydrates.

The "core" or "cob" has a slight feeding value. Some farmers grind the whole of the ear, i.e., the grain and the cob, together, and the meal thus produced is then known as "Corn and Cob" meal. It is difficult and expensive to grind the "core" to a reasonable degree of fineness, and it is somewhat doubtful whether the feeding value of the "core" is worth the cost of grinding. In this connection it is believed that the principal function of the "core" in such meal is to lighten the mixture, thus facilitating the digestion of the ground corn grain.

The unit by which maize grain is sold is the "bushel". The bushel proper is a measure of capacity, but maize is not measured but weighed, and the term "bushel", as understood in connection with maize, is a conventional one and means 56 lb., which is the approximate weight of a measured bushel of grain. To sell a bushel of maize is therefore to sell 56 lb. weight. About 75 lb. weight of "ears" will produce about 56 lb. (1 bushel) of grain.

The stalks and leaves—"stover"—which are left after the "ears" have been removed contain about one-third of the total food produced by the plant. Therefore much will be lost if this is not saved. If left in the field its food value rapidly diminishes. Because of this the more modern practice is to cut the crop (stalks and grain) after the grain has commenced to colour and dent, and tie the bundles and stook them until the grain is dry and the stalks cured, say, five or six weeks. The cobs are removed and the fodder stored away until required.

The "stover" is not as valuable as the maize fodder (green stalks with unhusked cobs attached) but is very useful for idle horses, and for the maintenance of dry cattle over the winter. Its value is enhanced when the stalks are run through a chaff-cutter or shredded, i.e., dealt with by a machine which tears the stalks into strips or shreds, and known as a "shredder". Machines are now available which will take the corn stalks with cobs attached and deal with the whole material, husking and shelling the cobs and shredding the leaves and stalks in one operation.

Henry, in his "Feeds and Feeding", has pointed out that the results of experiments conducted by Ladd, at the New York (Geneva) Experiment Station, show that the nutrients in a crop of maize increase very considerably from the time of tasselling to maturity. When tasselled the crop weighed nine short tons (18,045 lb.) more than eight of which were water. The weight of the crop continued to increase until the grain reached the full milk stage, after which it decreased. Between the milk and glazing stage there was a loss of water, but a remarkable increase in quantity of nutrients, as shown by an increase of over a ton of dry matter in 17 days. From the glazing period until fully ripe there was a further slight increase in nutrients. The results show that through the various stages until the "glazed" period there is a constant and considerable increase in the nutritive value of the plant. Because of this the crop intended for fodder should not be harvested before the grain is glazed. For silage purposes it should not be delayed beyond this period, as the plants then contain the proportion of water required for good results.

The green crop can then be cut with a short scythe, cane knife, or hoe. For large areas a special machine known as a "maize harvester" is on the market. This machine cuts the stalks and binds them into bundles, just as a reaper and binder deals with the wheat crop. The advantages of such a machine when making silage are obvious.

For silage the green material is placed at once, preferably chaffed, into the "pit" "trench" or "above ground" silo, or unchaffed into a stack. It is important for those who have silos to realise that if desired the material can be used from the silo immediately after being placed therein. In this way the silo acts as a store house to enable a green crop to be harvested at its most nutritive stage, and used whilst in that condition.

The green fodder can be made into good coarse hay, and for this purpose should be tied into handy sized bundles or sheaves, and a number of them, say, five to seven, stooked together in the field until thoroughly air

dried. It should then be placed under cover and chaffed before being fed to stock. The disadvantage of making it into hay is the long period necessary for curing—five to six weeks—during which time a considerable amount of food material is lost.

Valuable as the maize fodder is, it must be recognised that it is not a complete food in itself for dairy stock or working animals. Just as bread forms a very solid foundation in the dietary scale of human beings, so maize fodder, whether as silage for milch cows or hay for horses and dry cows, can play a similarly useful part in the rations of farm animals. Even well-cared for "stover" has a greater feeding value than is generally believed, and is most suitable for idle stock during the winter. All forms of maize fodder can be utilised to supply in a cheap way the bulky and carbonaceous part of the food required by milking cows. To obtain the great benefits capable of being derived from its use with milking cows or young stock, it requires to be fed in conjunction with some legume, such as the clovers or lucerne, which should be grown on the farm to maintain, and even increase, its fertility and at the same time supply the protein and ash, the food constituents in which maize is somewhat deficient.

THE MYSTERY OF THE SOIL*

"NATURE in the raw" may be seldom "mild" but mild or harsh, it has always been a deep, dark mystery to the limited intellect of mankind. The ancients reverenced everything which was mysterious to them, believing that "the gods" were responsible. They feared to attempt an examination of any of the things which mystified them lest "the gods" be angry and visit their wrath upon the rash, presumptuous investigator. Hence it was that the multitude of natural phenomena which forced themselves upon the attention of those primitive people were awe-inspiring and interesting, but not at all understood and, indeed, and not even the subject of investigation! Nature was accepted as it was—the gift of the gods and under the control of the gods! The only thing necessary was to keep the gods properly propitiated and everything would be lovely!

This calm, comfortable philosophy of the "early settlers" was gradually replaced by the "enquiring mind" of the beginnings of so-called civilization. The gods were often difficult to conciliate and in spite of all manner of sacrifices, things did not always go right. Certain individuals became so curious that they braved the wrath of the gods and delved into the various mysteries. And lo! nothing happened to them! The wrath of the gods became a thing to be mocked and ignored. And so investigational work began! Soon the physical sciences appeared and gave their aid toward the solution of nature's mysteries. Civilization developed, science developed, research developed! Or as some would have it, research began, science appeared and as a result civilization progressed! Perhaps so! At any rate many of the former mysterious occurrences were soon "exposed" as natural happenings. The old myths were largely exploded. The "why" of numerous strange things in nature has now been discovered. Science and knowledge and civilization have increased and developed at an amazing rate and the accumulation of known facts regarding Nature has become stupendous.

But have the mysteries of Nature all been solved? Far from it! We become so enamoured of our remarkable achievements that we are inclined to feel that we have just about reached the peak of scientific development, the summit of knowledge. Those who follow us, will have trouble in finding problems to work on—mysteries to solve! In the most reprehensible but withal expressive language of the day "Oy, yeah—you're telling me?"

Do not be deluded, complacent, sated with the extent and importance of the achievements which have been made in all the natural science lines. Mr. Sherlock Holmes and his able assistant, Dr. Watson, as investigators of the mysteries of Nature will find plenty of mysterious occurrences in the every-day world round us, upon which to test their intuitive powers, their scientific deduction, their amazing analytical methods! The unsolved

* Presidental Address before the 25th annual meeting of the American Society of Agronomy. By P. E. Brown, in *Journal of the American Society of Agronomy*, Vol. 24, No. 12, December, 1932.

mysteries of Nature are still legion. There is very far from any dearth of problems, upon which the students of the future may test their "detective" powers.

Among all the mysteries in the world of Nature, the mystery of the soil stands out prominently at the present time. This is largely due to the fact that Soil Science, among all the sciences of Nature, has been late in developing. It is only comparatively recently that it has really reached an individual science basis. Just why it should have been so slow in developing is difficult to determine. But is probably due to the fact that the study of plants and animals proved so extremely interesting and important and there was nothing attractive in working with "dirt". One of the most deplorable and maligning beliefs of many people, including some scientific workers, has been that soil was "dirt". It has taken years and will take many more before we shall hear the last of that great fallacy! One of the first lessons we have been teaching for many years in our Soils courses at the Iowa State College is the distinction between soil and dirt and woe betide the student who refers to soil as dirt—at least in our presence! We really get them broken of the habit. And I am inclined to believe that we are making some progress with all agricultural people. Not nearly so many persons come into our office and say "I have some dirt to be tested".

Logically the study of soil should have been carried on much more intensively and extensively years earlier. The soil is the basis of all agriculture. It is fundamental to food production—to the feeding of the human race! But too long it was looked upon as a mere inert, static medium, upon which plants grew or did not grow—a material which covered the surface of the earth and differed somewhat in various places, because of variations in the rocks from which it was presumably formed, because of the climatic conditions to which it had been subjected, and because of the character of the vegetation upon it. Here I may digress a moment to call your attention to the fact that this is one of the mysteries of the soil which is still unsolved. Perhaps it never will be! The question is like the old one "which came first, the chicken or the egg?" Are the characteristics of soil types determined by the type of vegetation occurring on them in a native or virgin condition? Or is the type of vegetation a result of the soil type character—at least in part? Some of you may have an answer to the question. Personally, I have. But whatever view is held, there is bound to be discussion. I submit that it is one of the most intriguing mysteries of Soil Science, which may engage our spare moments when we have nothing more vital to occupy us. There are so many other more important mysteries demanding solution!

But whatever the views of the early agricultural scientists, whatever the reasons, the fact remains that it has only been comparatively recently that the soil has received the attention of scientists which it should have had long ago. It was not until the emphasis was placed upon the soil *as soil* not as a geological, chemical, or physical material, not merely as a material which would support plant growth, but as a dynamic material *of itself* and *in itself*, a place of the deepest, darkest mysteries of nature, that a real study of the soil began.

Now there has developed a real Soil Science—a science established by the accumulation of a vast mass of facts, the solution of many of the simpler mysteries, occurring beneath the surface of the earth, beyond the vision of man, the evaluation and interpretation of data and observations made incidentally and often accidentally over long years of what may be called the period of "soil ignorance", and by the systematic, scientific study of soils *as soils*.

I would not for a moment minimize the value of the work of those early agricultural chemists and of the pioneer soil workers who sought so diligently to uncover some of the laws governing the growth of plants upon soils. Their labours were not in vain! They paved the way for the development of the real Soil Science. Many of their results are of unquestioned significance when interpreted in the light of our present knowledge and from a soil's viewpoint.

One of the most interesting observations to be made at the present time, as Soil Science develops and as Crop Science develops, is that these two sciences are not growing apart but they are coming to depend more and more upon each other. Each is finding the other science of more and more use to it. The two together make up what we call Agronomic Science and both are vital to Agricultural Science. They should develop side by side, hand in hand. Only by the most intimate contact and the fullest recognition of the accomplishments of the other science, will either make the most progress and contribute all that it should to the agriculture of today and tomorrow. May I point out that here in the American Society of Agronomy, these two young sciences are meeting together in annual meetings, in the columns of our Journal, and in the exchange of ideas among the workers in both lines. It's a worth while, a very desirable—yes, I believe an essential union of these two sciences! Let us go on into the future—as we have for the past twenty-five years—hand in hand, realizing that there are real benefits to be derived by both crops and soil specialists by this inmate contact and that each science must draw up on the other for all the clues available to help in solving its mysteries.

Now I have labelled this address "The Mystery of the Soil" but there are really numberless mysteries still to be solved. All may be grouped together, however, in one great mystery, toward the solution of which the solving of each minor mystery will contribute. While I would not venture to discuss the mysteries of Crop Science, I submit that all the various soil mysteries effect crop problems. Then, too, practically all the soil problems have a crops angle or need the aid of some crop studies to provide a full and complete solution.

The mystery of the soil is an extremely complicated one with many ramifications. In other words there are so many characters in the mystery play, the scenes are so varied, the scenery and stage settings are so confusing that there are too many clues. There are so many who might have committed the murder and had good reason for doing it, there are so many finger marks and footprints, so many involved situations, so much moving of the furniture, so many spots upon the rugs and wall paper, such a vast accumulation of peculiar happenings before the murder and immediately following it! None of the suspects can establish an alibi. No one can

answer all the hypothetical questions put by the expert detectives. The trained blood hounds lose the scent. The heavy rains obliterate traces left by the suspects. Some of the important witnesses disappear under most mysterious circumstances. At midnight, with deep black, dank darkness all round, an apparition with ghostly face and long trailing robes appears and some one dies of fright. A detective goes crazy and must be calm and restored to sanity. Thunderstorms of terrific intensity occur frequently with torrential rain and blinding lightning flashes! Poison appears in the food, the water supply is contaminated or fails utterly. Then just as it appears that the mystery will be solved and the murderer apprehended, the plot thickens and then thickens some more and one who at first seemed to be a deep-dyed villain turns out to be a blue-eyed lover whose idiosyncrasies which have so confused the sleuths and perturbed all the characters are found to be due to the "insanity of love". Then the female vamp appears in her usual rôle and one wonders why she was not murdered instead of the good, kindly, beloved, gracious but withal rich old gentleman whose dead body was found in the grove of the fine old country estate not far from the mansion itself which was filled with guests, relatives, and servants, as motley a crew as could possibly be conceived. Several villains appear on the scene and numerous heroes and heroines. Invisible forces, the so-called occult, get into action. The whole mystery is soon resolved into an extensive series of sub-mysteries, all of which must be solved before the "killer of the good old man" can be revealed. "The Phantom of Crestwood" or "Who Killed Jenny" is a simple, very simple mystery compared to that which I have outlined. Those of you who have been so frivolous as to read mystery stories may recognize some of the references. Most of you probably have spent or misspent some time in such vain pursuit of entertainment. But they do make wonderful vocation reading material, real relaxation!

Now I shall not attempt to go back over this extravagant outline of a murder mystery as it might have been concieved by a combination of Sherlock Holmes, Charlie Chan, and all the other famous detectives who have evidenced the super-intellect which would solve all mysteries, to point out all the analogies to the mystery of the soil. Striking comparisons are possible! I am sure you will all recognize them.

The good kindly old man who was killed, thus furnishing the theme of the mystery, might be looked upon as old "Father Agriculture." At the present time it looks as if that murder had really been committed, and the fixing of the responsibility an impossibility! But our victim in the soils mystery, is the poor, old worn-out soil, the once healthy, vigorous, kindly support of the whole family. Killed in cold blood, without mercy or the slightest consideration of the consequence—under the most unusual conditions, a whole bevy of witnesses, villains and heroes, friends, relatives and enemies, and mere on-lookers. In fact, with the whole world looking on. And the scene laid under the most complex situation imaginable. Can anything more complex be imagined than the soil ? Physical forces, chemical forces, biological forces, yes, even what seem to be occult forces are operating. Who or what killed the old man ? Was it some physical force, some chemical force, some biological force or was it an economist, who frightened him to death? The investigation of the mystery has begun. Soil Science has undertaken the task in a vigorous, logical way.

But there are so many subsidiary mysteries to be solved first that progress is necessarily slow. Eventually the whole horrible plot will be exposed in all its appalling details. At present we are in the midst of the mystery story. We are making progress, although at times the plot thickens and we become much confused. Clues appear at every turn, some false and useless, some adding to the facts which will finally give us the solution of the mystery.

There is not time to enumerate all the subsidiary, secondary mysteries which are now engaging our attention. But some of the more important may be listed. Others will occur to all of you. In fact, it is difficult, if not impossible, to think of even one of the soil questions which we are being called upon to answer now without realising that some mystery is involved. You will say "why we do have definite fixed answers to many soil questions—we have established some facts". True, but I challenge you to cite a single one which cannot be shown to be surrounded by some mysterious circumstances *under certain soil conditions*. We may know what happens to a crop grown on a soil treated in a certain way, or on many soils receiving a definite treatment. But do we know why? No—it's a mystery! Do we know that the same effects are occurring in all soils? No—it's a mystery!

Now for some examples which will indicate specifically what I have been discussing in more or less general terms. First, let us consider liming. We know that liming benefits the growth of legumes on most acid soils. But some legumes grow well on certain acid soils and not on others. Why! Buffering in the soil? Perhaps. If so, what is buffering? Adaptation of the crop or variety ? (A crop science problem). If so, why and also how ? Inaccurate tests for acidity or apparently good tests which do not work under the particular conditions.

Inoculation of legumes occurs best on non-acid soils. The legume bacteria seem to prefer basic conditions for their growth. In fact, frequently they will not grow under acid conditions. But sometimes they do! Sometimes well-inoculated legumes are found growing in strongly acid soils. Why and how ? Is it an adaptation of species ? Then, too, if the legumes are inoculated, are they drawing upon the free nitrogen of the atmosphere ? If so how much and how ? Do nodules on the roots of legumes mean fixation of nitrogen? Not necessarily. It's a mystery? When and how do legume bacteria fix nitrogen ? Why will they utilise atmospheric nitrogen when in the nodules but refuse to do it when growing alone under presumably very favourable conditions ? If there is an abundant supply of nitrogen in the soil, will nodules form ? If not, why not ? If they do form under such conditions, are they of any value or mere adornments, useless appendages, or parasitic infestations? It's all a mystery!

When we consider the whole legume problem, there we find many of the most interesting and import mysteries. There's the Dr. Jekyll and Mr. Hyde existence of the Rhizobia. Sometimes of one form, size and shape, sometimes of another, sometimes present, sometimes absent; sometimes active and efficient, often weak and ineffective. Variations in strains occur but they are not constant. Certain characters vary with the strain.

When are they weak organisms and when strong ? How can they be distinguished ? Why do they vary ? Then there is the problem of cross-inoculation. Why do some bacteria inoculate several legumes while others infect only one variety ? But enough of this particular mystery! Some progress has been made in the solution of this mystery of legume inoculation and the bacteria involved, but it is still far from being fully solved!

To return to liming and acid soils, it might seem that there we have a mystery that has been solved. But far from it. What kind of lime shall be used ? How and how often ? What does it do to the soil ? Can we put on too much ? How about magnesian versus calcium limes for soil use? And there are a multitude of other questions involved in liming, the answers to which are not yet available. What is soil acidity ? Are soil acids toxic to plants ? Is there a soluble aluminum toxicity ? Who can say—*for all soils* ? Liming of soils presents a mystery which has been studied for a long time, but it is still unsolved. Let anyone who thinks it is, stand forth and answer some of the above questions.

Again, may I emphasize the fact that Crop Science is involved in both the soil mysteries just discussed, liming and legume inoculation. And there can be no question of the significance of both these problems to the agriculture of extensive areas throughout the land. Fortunately, practical agriculture is not obliged to wait for the final solution of the soil mysteries before profiting by the facts uncovered in the course of the study of the mystery. The valuable effects of growing inoculated legumes and of liming acid soils have been generally recognized and these practices have become basic parts of all sound soil management programmes. But the final solution of the mystery will place these farming operations upon a more sure, sounder basis.

Then we may consider the still more complex problem of organic matter in soils. The mystery of this material, its decomposition and its functions in soils is still only in the initial stages of solution. It varies so widely in composition, character, and rate of decomposition and the variety of products is so great that it presents a whole series of mysteries all its own. Much has been learned about organic matter and quite recently contributions of fundamental significance have been made. But the story is far from told! What is the reason for the difference in the rate of decomposition of certain green manure crops ? Why do non-leguminous green manures prove as effective as legumes under certain conditions ? Why and how and when should green manuring be practised at all? What is the effect on various soils? Why do cornstalks decompose in the soil and how? What fertility value have they? A very important question now, by the way, in connection with the industrial utilization of agricultural waste. How about grain straw ? How should it be utilized? Has it any fertility value? When and why does it have a deleterious effect on soils and crops ? How is it decomposed in the soil? What are the effects of different straws? What is the influence of certain fertilizers such as nitrates on the effects of straw ploughed under in soils?

How about artificial manures? Can they be made practically, from waste materials, from straw etc.? What are their effects on soils? How many other forms of organic matter find their way into the soil—what do they do? How are they decomposed? What effects do they have on crop growth?

Then there is farm manure. How much is really known about farm manure and its effects on soils? Imagine a material as complex as soil, treated with another material such as farm manure just as complex if not more so, and then attempt to figure out what happens. Is it any wonder that it constitutes a mystery? But it is an interesting and an important mystery. Is it the plant food in the manure which makes it of value? Is it the chemical effects, or is it the biological effects? Studies have been made along this line but owing to experimental difficulties impossible to overcome, the mystery has not been solved. What is the composition of manure? That is about as easy a question as "how old is Ann?" It cannot now be answered. Will it ever be possible to answer it satisfactorily? Who knows? What does manure do to the soil? How does it change the soil conditions and as a result the growth of the plant? Again, a Crop Science relationship appears! How shall manure be applied? When? How can it be conserved for application, when it must be stored? These are practical problems. Everyone knows the value of farm manure in bringing about increases in crop yields on most soils, but there are many unsolved mysteries involved in the effects of the manure and in the material itself! The bacterial life and action in farm manure and the occurrence of other micro-organisms make a series of mysteries which it will take many years of intensive work to unravel!

Then, too, the question arises, "Is organic matter necessary for the most economic crop production, for permanent soil fertility. On the one hand, there is the evidence of centuries to show, practically, the value of applications of manure on crop production, and this value is assumed to be due mainly to the organic matter supplied, if not entirely so. On the other hand, the question may be asked "Can soils be kept productive without manure?" It may also be asked, "What can the grain farmer, or the general farmer do, when there is no farm manure produced to apply to the land?" These latter questions have been answered practically by recommendations for the use of crop residues and leguminous green manures. Abundant evidence has been secured on the farm to prove the value of these sources of organic matter. But the question still unanswered is, "Can something else be done to keep soils productive without adding organic matter?" Future studies along this line will undoubtedly provide some evidence pro or con. At present, the maintenance of a supply of organic matter in soils is considered essential to permanent fertility! Suggestions to the contrary can have little practical support until data are available to prove the contention. We owe to posterity the obligation of standing for the fundamentals of permanent soil fertility and hence a permanent agriculture, according to the present evidence available—according to our lights! The mystery is not solved!

Then there are the problems of crop rotations and of the effect of one crop on another grown with it and on the succeeding crop. Are these Soils or Crops problems, you ask? Well, on the advice of counsel, I refuse to incriminate myself by giving a definite answer. Certainly the problems involve both sciences directly. They are important in many ways to soil questions. What are the effects of different crops on the soil? A mystery! What are the effects of rotations, of varying rotations on the soil? Another mystery! When one crop grown on the land has a certain effect on the succeeding crop, what part does the soil play in the phenomenon?

Again a mystery! Practically, we recommend certain rotations for special combinations of conditions, soil, climate, season, etc. We recommend certain special crops for some conditions. But these recommendations are based on the results secured *in crop yields* under particular experimental conditions. Can the results be guaranteed for other soil conditions? Do we know why? "No, we certainly do not"! It's a mystery!

Let us now turn to the problem of fertilizers and their use. This is such a vast problem, such an important subject that some believe it will become a science of itself. Perhaps so! But at present it is a part of both Crop Science and Soil Science and even if it does eventually become a separate individual science, it will still be of great significance to both sciences. But now it may be pointed out that there are a multitude of mysteries involved in the fertilizer problem, in the use of commercial fertiliziers on land to increase productivity in an economical way and aid in keeping the soil permanently productive.

First of all, may I point out that the fertilizer programme of the past has been centred around nitrogen, phosphorus and potassium as the essential elements for plant growth, which are likely to be lacking in soils. But now numerous other elements are coming to be considered. Sulphur and calcium were added comparatively recently and at present we are giving careful thought and attention to certain other elements—some of which have previously not been deemed of any importance in plant growth. What elements should be supplied in a commercial fertilizer? It's a mystery! How about magnesium manganese, iron, boron, iodine, and many other elements? Some investigations with certain elements indicate that we have only made a beginning in our studies of the constituents which should be added to soils commercially. We have only been gathering a few clues toward the solution of the mystery.

Then there is the question of testing soils or plants to determine the need for the addition of certain fertilizing materials. Many tests have been suggested. Some seem to give excellent results under certain conditions but refuse to work under other circumstances. The commercialization of the test has speeded up work along this line, but it is still a mystery what tests should be devised to work under all conditions! The problem is still before us. Some progress is being made, but it is safe to say that no methods have yet appeared which can be depended upon to give absolutely reliable results under all conditions! Why not? That's the mystery! Why do the results with different tests vary! Another mystery!

When the large number of commercial fertilizers on the market is considered, it becomes apparent that the problem of fertilizer use is an extensive one. What is the relative value of mineral nitrogen and organic nitrogen? What are the relative effects of various mineral forms and of different organic ammoniates? How do the synthetic products compare with natural materials? When and how and how much of the various materials should be used? These are all practical questions, not yet answered. But there are even more numerous technical questions involved. What are the effects on the soil of the various materials? Are the effects direct or indirect or partly direct and partly a result of modification of soil conditions? Why do certain materials have particular observed effects?

The same questions may be asked regarding phosphorus, potassium, and complete commercial carriers. How about that old question, "Shall we use rock phosphate or super phosphate"? Has it been answered? Not yet! I speak of this question especially, as it has presented a problem for years and many of us have been under great pressure to secure an answer. It seems that an answer should have been secured. But one cannot yet been given! It's still a mystery! In connection with phosphorus fertilization, I may also mention the problem of the effect of phosphorus carriers on the reaction of the soil and its need for lime. What changes in reaction, if any, are brought about by different phosphorus fertilizers? Do they have any neutralizing effect on acidity? There has been much talk of such an effect but little evidence. Now we believe little or no neutralizing effect on acidity can be expected from phosphate additions. But future investigations may lead us to change our views. It's a mystery!

When potassium fertilizers are considered, there are many problems there. One may be mentioned as of particular interest now. Why do potassium fertilizers prove of value on high-lime and certain so-called "alkali" soils in the humid region? These soils contain large amounts of total potassium. What has happened to the availability processes and to the potassium in those soils? Suggestions have been offered, but the real solution is still a mystery!.

What complete fertilizers should be employed and when and how? We are securing data along these lines all the time—some of great significance. Great progress has been made but no answer can be given yet. It's still a mystery! High analysis versus low analysis materials, the exact formula to employ, the constituents in the fertilizer, home-mixing, the amounts to add to soils, broadcasting versus application in the hill, and how to secure a satisfactory application, are some of the problems under study, but they are not solved. Again we are gathering clues! But what are the effects on the soil of the different materials, variously applied? What is the reason for the influence on the crop? Is it a direct fertilization of the crop or is it a fertilization of the soil, of the rotation? Are these effects due to secondary influences (perhaps they should be considered primary) on the soil conditions? What are the residual effects, if any? What are they due to? It's all a mystery!

Perhaps I should also mention the effects of drainage, irrigation, cultivation, and other normal or special farming operations. The beneficial effects of removing excess water and of adding water when there is a deficiency are well known and primarily, practically, not at all mysterious. But the question here—and it's a mystery—is what is going on in soils that are too wet or too dry? What are the effects on the soils from drainage and irrigation? Then there are the questions, "Why cultivate corn and how often? What does the operation do to the soil along with the very obvious effect of reducing weed growth? How is the water content influenced? How are microbiological activities affected? What is the influence on the crop as a result of these effects? Why fall-plough? Why spring-plough? How about the depth of the seed bed? What are the effects of subsoiling, of rolling, of burning?" These are all mysteries!

Then the problem of erosion, control and prevention should be mentioned. How serious erosion may be can only be estimated. It is so enormous that we are startled and appalled, but what are the effects on the

individual farm? How can erosion be thoroughly controlled? How can it be prevented? What are the effects on the soil of such operations as terracing and other methods used in checking soil washing? How long will it take and what means can be employed to make a productive soil from a subsoil exposed by washing away of the surface soil? Many more questions regarding erosion and its control might be suggested. Much is being accomplished in a practical way, but the whole problem is still a mystery!

The problem of pastures should not be overlooked. How can permanent bluegrass pastures be maintained? What fertilizers should be employed? How should the pasture areas be handled? What about discing, reseeding, liming, fertilizing? When should the pasture be ploughed up? These are all practical problems which have not yet been solved. We are making progress and some fine pasture experimental work is in progress. But it is a complex problem and is still a mystery. From the technical side, many "whys" might be asked in connection with the pasture problem. There are numerous mysteries involved!

Enough has been said to make it quite apparent that there are literally hundreds, yes thousands of soil mysteries still remaining to be solved. Can there be any doubt regarding the mysterious nature of the soil, the important problem confronting us in the solution of the great mystery?

Why is there a soil mystery? This is a logical question which follows all that has been suggested. It is only comparatively recently that we have been finding out why. Of course, it has been known for a long time that soil was a complex material and hence might be expected to be filled with mysteries. But now we are coming to know soils as *soils*, to group and classify them on a more or less definite scientific basis which is rapidly becoming more and more definite and more and more scientific. The work of the soil survey, the mapping, classification, and study of soil characteristics carried out in connection with the survey, have enabled us to probe deeper into the mysteries of the soil and are providing a basis upon which a solution of the mystery can be reached. Of this we are confident! The fact that there are soil types, soil individuals as it were, has been established. True we do not yet have all the information we need on any of the types, but data are rapidly being accumulated and the development of Soil Science on a soil type basis is occurring with astonishing rapidity. The fact that there are soil types, definite in characteristics, occurring in certain areas, and under fixed conditions, but *differing from* all other soil types in many particulars, explains why there are so many mysteries in the soil as indicated in the previous discussion. Why should any soil treatment effect different soil types in the same way? It would be too much to expect. Why should it be assumed that the same results should be secured in any test where the soil type is not the same? It should not. The soil type may still be more or less of a mystery and it certainly is, but it is the mystery behind the big broad mystery of the soil, its management, and permanent fertility!

Much remains to be done on the study of soil types. The measurement of the physical characteristics of various types is proving a difficult problem. But it will be solved and exact physical descriptions will eventually be possible. Chemical studies are also providing problems which are

requiring extensive work and we are still far from having methods entirely acceptable. They will come and exact chemical descriptions will be possible.

When we come to the microbiological factors involved in soil type separations, the situation is found to be even more complex, if that can be conceived of as possible. Microbiological studies have yielded information of great significance, but a start has hardly been made in the determination of the microbiological activities occurring in different soil types. We know literally nothing of the exact action of bacteria and other micro-organisms in the formation of soils, in the changes constantly occurring in soils during the formative period, after maturity and in the old age, or period of decadence, of soils!

Along this line I may mention some of the outstanding mysteries which we find from a brief consideration of micro-organisms in soils and their activities. What organisms are present in different soil types? Why are certain species present? Why are others absent? These questions involve the problems of the source of the organisms, the development or lack of development in the particular soil, and the influence of all other soil conditions. There are also the influence of one group of organisms on another, the activities of the various organisms, and the efficiency of the organisms to be taken into account. What about the occurrence of moulds, actinomyces, algae, and protozoa, as well as bacteria? Do they work together or in opposition? What is the effect of one group on another? How much anaerobic microbial action occurs in soils? Are there life cycles of the various organisms? What are the stages? What about spore formation, motility, multiplication, physiological efficiency of the different forms? Are there only a few species of nitrifiers? What do the aerobic non-symbiotic nitrogen fixers really do in soils? How about the action of the cellulose destroyers? What is the importance of the nitrate assimilators? What significance is connected with the sulphur oxidizers in various types? What relation do micro-organisms have to potassium, calcium, magnesium iron, aluminum, and other elements? Thus each micro-organism have one major function in soils or do they all participate in numerous activities? What about enzymes and their action in soils? And so on and on! There are certainly many mysteries here which must be cleared up before we shall have the necessary data to describe soil types properly from the microbiological standpoint.

Then we come back to a question similar to one suggested earlier in connection with the native vegetation on a soil. Are the bacteria and other micro-organisms present in soils and are their activities a result of soil type conditions or do the micro-organisms have an important part in the differentiation of types? We do not know! But we are convinced that micro-organisms have played and do play a vital part in the formation of soils and hence of soil types and also in the development and ageing of soils. What have they contributed? How have they acted? When and how did they become active? Speculation is rife on this point, but naturally this mystery cannot be solved except by deduction and ratiocination. Eventually this will be done! Until then it's a mystery!

It is obvious that the mysteries of the soil type, physical, chemical, and biological, are extremely numerous and I have not even mentioned colloids, base exchange and a host of other "family pets". All the mysteries are being solved one by one and the work of the future will bring many more solutions. The classification of soils into types is fundamental to the rational development of Soil Science. The solution of the soil type mysteries will provide basic clues to the solution of the big mystery of the soil itself, to the clearing up of the mysteries involved in soil management, permanent soil fertility, and a permanent agriculture!

All this may seem a dark, depressing, even pessimistic discussion. It has not been so intended. You may be thinking that I am merely suggesting the vast number and great importance of the things we do not know about soils and Soil Science! It may seem that I have overlooked all that has been done and all that we know now! That is far from my intention!

I would not for a moment give the impression that the work which has been done is not important. It is! May I reiterate the statement that probably no other science has made such rapid progress as has Soil Science. There is already a vast collection of clues piling up, as a result of the extensive studies under way and these will eventually lead to the solution of all the mysteries. But I cannot provide the conclusion to this soil mystery such as is always expected and given in mystery novels. The murderer is found, usually the most unlikely person. The strange occurrences, the distracting clues, the false scents, the fantastic theories are all readily explained. The innocent suspect is freed and lives happy ever after! The death of the victim is avenged—the murderer pays the penalty! "Crime does not pay".

Eventually the mystery of the soil will be solved. But it will not be in my time or yours! Great progress is being made! Already the crime of killing the poor old man "Soil" has been found not to pay. The murderers are finding this out! It is becoming a recognized fact that good soil management pays! To keep the old man alive and vigorous is now quite the thing. Farmers are actually becoming "soil conscious". They are recognizing that the soil is their one great asset and the basis of all their operations, of their success or of their failure. All people are coming to a realization that the soil is the national resource of the land which must be conserved to permit of a future agriculture, a future adequate production of food for the human race!

It is up to us to do all that we can to solve the mystery of the soil in order that we may have proper and adequate soil management practices and that the great natural resource of our country may be conserved for the support of future generations!

Agronomists, soils and crop specialists, it is up to you to continue to develop your studies along all these lines in order to hasten the arrival of the denouement of the great mystery! It will come! Of that we can be sure! No disappointments or discouragements, no futile disagreements or discussions should be permitted to take our attention from the desired goal! There is an infinite amount of work to be done. There are many clues to be traced! Our goal is the solution of the mystery of the soil! Let us push on!

MEETINGS, CONFERENCES, ETC.

THE TEA RESEARCH INSTITUTE OF CEYLON

Minutes of the Meeting of the Board of the Tea Research Institute of Ceylon, held in the Grand Oriental Hotel, Colombo, on Friday, the 15th December, 1932, at 9.30 a.m.

Present.—Mr. R. G. Coombe (Chairman), the Acting Financial Secretary (Mr. C. W. Bickmore), Col. T. G. Jayewardene, Major J. W. Oldfield, Messrs. A. G. Baynham, G. K. Stewart, M.S.C., D. H. Kotalawala, M.S.C., R. D. Morrison, I. L. Cameron, John Horsfall, Jas. Forbes (Jnr.), A. W. L. Turner (Secretary), and as visitors, Mr. J. W. Ferguson, Dr. Roland V. Norris (Director, T.R.I.) and Dr. C. H. Gadd.

1. Notice calling the Meeting was read.

A letter regretting inability to be present at the Meeting was received from the Director of Agriculture.

The Minutes of the Meeting of the Board of the Tea Research Institute of Ceylon, held on the 28th July, 1932, were confirmed.

2. CHAIRMANSHIP

Mr. R. G. Coombe announced that he had returned from leave and resumed the Chairmanship as from the 26th November. He proposed that a vote of thanks be recorded to Mr. G. K. Stewart for having acted as Chairman during his absence.

3. MEMBERS OF THE BOARD, T. R. I.

Announced that Mr. Jas. Forbes (Jnr.) returned from leave and resumed his seat on the Board as from the 16th November.

Votes of thanks to Messrs. C. C. du Pré Moore and Huntley Wilkinson for having acted for Mr. Jas. Forbes and Mr. R. G. Coombe respectively were recorded.

Welcomed Col. T. G. Jayewardene who had been nominated by the Low-Country Products Association vice Mr. C. H. Z. Fernando who resigned as from the 22nd August.

4. FINANCE

(a) The Statement of Accounts as at 30th November were tabled.

On the proposal of Major Oldfield, seconded by Col. Jayewardene, the accounts as at 30th November were adopted.

(b) *Estimates of Income and Expenditure for 1933.*—The Chairman announced that the Finance Sub-Committee had held a Meeting on the 26th November, a copy of the Minutes of which had been sent to each member of the Board under cover of Circular No. A. 26/32 of the 5th December.

The Estate Estimates had been further considered by the Experimental Sub-Committee at St. Coombs on the 13th December and both the Research and the Estate Estimates had again been considered by the Finance Sub-Committee on the previous day. Copies of the final Estimates were tabled.

Research Estimates.—It was decided that the Research Estimates for 1933 be adopted.

Estate Estimates.—There was a discussion on the question of opening more land and it was finally decided with Mr. Jas. Forbes dissenting that no further land should be opened during 1933.

In reply to a question by Col. Jayewardene *re* Manuring, the Director stated that it had been decided to use inorganics rather than organics with a view to lessening the cost of this item. He expressed the opinion that it was the duty of the Institute to carry out large scale experiments of this kind for the benefit of the industry.

It was finally decided that the Estate Estimates as tabled should be adopted.

It was also decided that a small General Reserve should be created as and when possible, it being considered essential that the Institute should have funds available for the purchase of new machinery, etc. This General Reserve is to be supported by cash on Fixed Deposit at short call.

5. TRAVELLING ALLOWANCES

Announced that as a result of circulation of papers it had been decided that travelling allowances should be paid to members of the Board at a flat rate of 25 cents per mile to cover *all* expenses. This decision was confirmed.

6. SENIOR SCIENTIFIC STAFF

(a) *Director, T. R. I.*—Announced that the Director was due to proceed on leave on the 16th December, 1932, but in view of the coming Conference he was agreeable to postpone his departure until the 8th February for 8½ months.

The Director's agreement was renewed for a further of period of four years as from the 12th August, 1933.

(b) *Acting Director.*—It was decided that Dr. C. H. Gadd should act as Director of the Institute during Dr. Norris' absence.

7. JUNIOR STAFF

Mr. I. R. Nicol, Field Assistant in the Department of Physiology.—Announced that this Assistant's services were terminated on the 30th September.

Mr. F. H. Kehl.—Announced that this Assistant had succeeded Mr. Nicol as from the 1st October, 1932.

Provident Fund of the Junior Staff.—Announced that Mr. Jas. Forbes (Jnr.) having returned to the Island had relieved Mr. A. G. Baynham who had acted for him as a Trustee on the above Fund.

Mr. Baynham was thanked for the services he had rendered.

8. BUNGALOWS

Announced that the Senior Staff Bungalows Nos. 3 and 4 were taken over and occupied as from the 1st August.

9. ST. COOMBS ESTATE

(a) *Visiting Agent's Report.*—Announced that the Visiting Agent's Report, dated the 5th September, 1932, had been sent to each member of the Board, under cover of Circular No. A. 18/32 of the 13th September, and in view of his recommendations, the Board had decided that no pruning mixture should be applied to Field No. 8 in 1932.

Tea Manufacture.—The Acting Chairman's instructions that the factory should be largely used for experimental purposes were confirmed.

In this connexion the Director stated that a small Advisory Committee consisting of the Biochemist, the Superintendent of the Estate and himself had arranged to meet once a fortnight to discuss manufacturing problems. He undertook that a full report would be issued shortly to each member of the Board.

In connection with Manufacture, Mr. Stewart suggested that further Conferences between buyers, brokers and officers of the Institute should be held.

The Chairman undertook to see that this would be arranged.

10. SMALL-HOLDERS

Announced that 101 applications had been received for the post of Small-holdings Officer and that Mr. R. L. Illankoon had been appointed as from the 1st October.

Attention was drawn to a Memorandum drawn up by Dr. Gadd indicating the lines on which this officer would work, a copy of this Memorandum had been sent to each Member of the Board.

Mr. Kotalawala thanked the Director and the Chairman for the speed with which this appointment had been made and enquired what further action would be taken in the near future.

The Director replied that Mr. Illankoon was now going over his district and getting into touch with the Small-holders and with village officials and organisations. He would shortly put up proposals in regard to the demonstration plots. On receipt of Mr. Illankoon's report he would examine these areas personally.

Col. Jayewardene suggested and it was agreed that a half yearly report on small-holdings should be issued.

11. EXPERIMENTAL SUB-COMMITTEE

Announced that this Sub-Committee had met on the 14th October and a copy of the Minutes had been sent to each member of the Board. The Committee had held a further meeting on the 13th December, for the purpose of considering the estate estimates for 1933, as well as Manufacture Experiments.

Announced that Mr. R. H. Horne of Messrs. Forbes & Walker had accepted the invitation to serve on the Experimental Committee.

The Chairman's action in inviting Mr. I. L. Cameron to serve on this Committee was confirmed, as also was the appointment of Mr. Jas. Forbes (Jnr.).

It was announced that this Committee hoped to meet every two months.

12. TEA CIDER

Dr. Gadd said that experiments were still being carried out and he had found that satisfactory brews could be obtained by using cultures of two organisms only.

In reply to a remark made by Mr. Stewart, he stated that provided the cider were bottled at the correct time the cultures did not deteriorate but if a brew were allowed to become acid before bottling the cultures did deteriorate.

13. PUBLICATIONS

Announced that as a means of economy, the number of Publications had been reduced from 1750 to 1650 copies.

The Meeting terminated with a vote of thanks to the Chair.

A. W. L. TURNER,
Secretary.

DEPARTMENTAL NOTES

CITRUS CANKER

MALCOLM PARK, A.R.C.S.,
MYCOLOGIST

CITRUS canker is probably the most serious disease of citrus grown in the East. It is thought to have come from China in the first instance and it is very common in Ceylon at elevations below 3,000 feet on all varieties of citrus, although some are not so badly attacked as others. Grape-fruit is very susceptible to the disease while the mandarin orange is probably the most resistant species in Ceylon. Other species of citrus known to be attacked by the disease include lime, lemon, pummelo, citron, sweet and sour orange, mandarin and *Nataran*.

SYMPTOMS OF THE DISEASE

The disease is most common and characteristic on leaves although it also occurs on fruits, young green twigs and occasionally on larger branches. The leaves are the first place where the appearance of the disease should be sought. On these it forms small roundish cankerous spots up to one-quarter of an inch in diameter. The canker spot is readily recognisable by the naked eye, especially if the leaf is held up and the spot viewed with light coming through the leaf. Except in the earliest stages, the centre of the spot is light-brown in colour and can be felt as a rough raised outgrowth on both surfaces of the leaf. Immediately round the central raised area is an unbroken, narrow, darker oily-looking discoloured zone which in turn is surrounded by a broader, diffuse yellow area which appears as a halo round the spot.

The spots occur on any part of the leaf and are usually round although two or more spots may coalesce to form an irregular shaped diseased area. The disease is sometimes carried by the common leaf mining caterpillar and on some leaves the galleries of the insect are covered by numerous canker spots.

On the fruit the disease occurs as spots but the yellow halo is not so noticeable as on the leaves. The spots on fruits usually have a crater-like appearance and when the infection penetrates deeply an exudation of gum may occur. The value of fruits attacked by canker is reduced considerably but the disease is rendered more serious by the fact that fruit-rotting organisms which cannot attack healthy fruits frequently gain entrance through the canker spots and cause the fruits to decay.

The cankers on the green twigs have a similar appearance to those on the leaves and fruits. They may completely ring the twigs and so cause the die-back of shoots.

The disease does not cause the immediate death of trees and, apart from its effect on fruits, does not at first sight appear to be of great importance. Badly spotted leaves fall off, shoots are killed and in the course of time diseased trees, especially young trees, become unthrifty and a prey to other diseases which do not affect healthy trees.

THE CAUSE OF THE DISEASE

The disease has been proved to be caused by the bacterium *Psuedomonas citri*. The organism is not known to attack any plants outside the citrus family (*Rutaceae*). During periods of wet weather the bacterium, which is capable of free movement in water, is readily spread in rain drops, splashings and moist soil on the feet and clothing of man, by animals, birds etc. and by wind movements which bring diseased leaves into contact with healthy ones. Except in periods of dry weather all the citrus growing districts in Ceylon below 3,000 feet provide conditions favourable for the development and spread of the disease. It is commonest where there is an even distribution of rain throughout the year.

CONTROL OF THE DISEASE

Owing to its bacterial nature no methods of curing the disease are known and control can only be effected by the destruction of affected parts of plants, by the prevention of the spread of the disease and by the protection from the disease of healthy plants. In parts of America and Africa the disease has been completely stamped out by the complete destruction of trees and even of whole orchards where the disease has occurred. In Ceylon, where the disease is so wide-spread, such a measure would be impracticable.

The control measures recommended in Ceylon are as follows:—

1. Prune off and burn all die-back branches, cutting back to healthy wood.
2. Pick off and burn all diseased leaves, fruits and shoots.
3. Protect all citrus plants by spraying regularly once a week in wet weather and once a fortnight in dry weather with a reliable fungicide. Details of a cheap and efficient fungicide can be obtained on request from the Mycologist, Department of Agriculture, Peradeniya. Spraying has been proved to be beneficial and to give efficient control. The saving resulting from the improvement in the plants and fruits more than repays the cost of the fungicide and of the labour involved.
4. If possible protect citrus trees from the wind by growing other trees such as *Gliricidia* as wind-breaks.

CHEMICAL NOTES (12)

MARGOSA OIL AND OIL-CAKE

S. KANDIAH, DIP. AGRIC. (POONA).
ASSISTANT IN AGRICULTURAL CHEMISTRY

SAMPLES of margosa oil and cake were recently forwarded to this Division for analysis and report. As at present there is a desire in Ceylon for the investigation and utilisation of the less well-known local products, the following note on these two by-products of the *Margosa* tree (*Melia azadirachta*) which is quite common in the dry zone of Ceylon should be read with interest.

MARGOSA OIL

Colour—Brownish-yellow, cloudy

Specific Gravity at 25°C	·920
Acid Value	7·83
Free fatty acid per cent.	3·93
Iodine Value	66·9
Saponification Value	200·2
Refractive index at 27°C	1·468

The oil had been extracted from unhulled seeds. For comparison the iodine value of an oil prepared from hulled seeds was determined and it was found that there was no difference between the two oils in regard to this chemical characteristic. The oil is noted for its antiseptic properties and is used in ayurvedic medicine as an external application for sores and rheumatism. In India the oil is reported to be used for the preparation of an antiseptic soap. It is also reported that there is the possibility of this oil being used as a general insecticide and germicide in Australia. The oil is also used for burning purposes by the poorer classes, but the flame is smoky and the odour offensive.

MARGOSA CAKE

The cake was prepared from unhulled seeds, hence its manurial value will be comparatively low. For the sake of comparison, the analysis of a sample of the ordinary decorticated cake quoted in Watt's Dictionary of Economic Products of India is shown.

	Undecorticated cake per cent.	Decorticated cake per cent.	Mowra cake per cent.
Moisture ...	8·75	8·01	12·13
†Organic Matter ...	80·60	83·82	78·29
*Ash ...	10·65	8·17	9·58
	100·00	100·00	100·00
†Containing Nitrogen	3·19	5·24	2·85
* ,, Phosphoric acid	0·73	1·36	1·06
,, Potash	0·12	—	2·00
,, Lime	0·54	—	—

It will be seen that the undecorticated cake is inferior in fertilizing value to the decorticated sample owing to the presence of the shell. The cake contains just over 3 per cent. nitrogen and much smaller amounts of phosphoric acid, potash and lime. At the present market rate for groundnut cake, it is worth nearly Rs. 40 per ton f.o.r. Colombo. The decorticated cake contains as much as 5 per cent. nitrogen and should be worth correspondingly more.

As the cake has an obnoxious smell it was considered desirable to see if the cake will decompose and nitrify when applied to the soil under both dry and paddy land conditions. With this object in view two sets of laboratory experiments were started, one to study the rate of ammonification and the other of nitrification of this material. For the sake of comparison, groundnut cake was included in the experiment. It has been found that mowra or mahua cakes (*Bassia latifolia*) which is reported to have insecticidal properties, does not nitrify in the soil and it was also included in the trial. The nitrification experiment confirmed that although mowra cake contains about the same percentage of nitrogen as margosa cake, it does not nitrify at all in a period of eight weeks. The latter does so to the extent of 61 per cent. compared with groundnut cake. The percentage of nitrogen ammonified was much greater in each case. Mowra cake was found to ammonify to the extent of about 35 per cent., while as much as 89 per cent. of the nitrogen in margosa cake was ammonified during the same period.

Margosa cake is used in India for manurial purposes and it could be used likewise in Ceylon with advantage. The cake prepared by the local method may possibly contain a high percentage of oil in it and this would delay its decomposition to a certain extent. An application of this cake was made to a small plot of paddy land at Gangoruwa and the crop seems to have benefited by it.

EMPIRE MARKETING BOARD REPORT ON FURTHER EXPERIMENTAL CONSIGNMENTS OF MANGOSTEENS FROM BURMA, 1932

1. In continuation of experiments carried out in 1929, 1930 and 1931 two further experimental consignments of mangosteens were forwarded during the 1932 season by the Department of Agriculture, Burma to the Indian Trade Commissioner in London. These were examined and reported on by officers of the Empire Marketing Board in co-operation with Mr. Gregson, Deputy Director of Agriculture, Tenasserim Circle, Burma, who was on leave in England at the time.

In view of the desirability of testing the market for mangosteens it was decided in consultation with Mr. Gregson, that the majority of the fruits should be sold. The consignments were accordingly placed in the hands of a Covent Garden merchant immediately after arrival, and as a result the samples examined in detail were small, but it was endeavoured to make them as representative as possible.

In addition, a small consignment of canned fruit was sent with each shipment for a report on the quality and suitability for market.

2. FIRST SHIPMENT OF FRESH FRUIT

The first consignment was shipped from Rangoon on the 14th April and arrived at Tilbury on the 13th May. By arrangement with the shipping company the fruit was retained under refrigeration over the week-end and discharged and forwarded to the Covent Garden Laboratory on Monday, 17th May.

The consignment consisted of 1,000 fruits packed in 40 wooden trays; 500 had been picked when just ripening, and 500 when almost ripe.

The average temperature of carriage was stated to have been 50° to 52°F. A self-registering thermometer which had been carried with the fruit indicated that the lowest and highest temperatures during the voyage had been 38° F. and 52° F. respectively.

3. CONDITION ON ARRIVAL

Just Ripening Fruits.—The condition of the just ripening fruits was variable, a few were full red in colour, others were almost full green, while the majority were partly coloured.

Three boxes were examined in detail and all the mangosteens were cut. The following table shows the condition:

Box	Number of fruits	Green or partially coloured	Even red in colour	Rotting
A 9	25	17	8	0
A 17	25	11	14	2
A 6	25	8	17	7
	75	36	39	9

Thus in a sample of 75 fruits some 12 per cent. waste was present. No external mould growth was present on the rotted fruits. The rind of the affected fruits was hard. Certain other fruits which appeared to be unrotted also had a hard rind. The rotting was present in the riper fruit of the sample. It can be seen from the table that the proportion of rotting increases with the proportion of riper fruit.

The flesh of the red fruit was attractive in appearance, juicy and of good flavour.

In the green fruit the flesh was hard and adhering to the rind, under-ripe and rather unpalatable.

Almost Ripe Fruit.—The almost ripe fruit was dark red in colour and attractive in appearance, and this was to some extent enhanced by the fresh green appearance of the calyx leaves. All the fruits had a hard rind.

Three boxes were selected for examination and all the fruit was cut, 25 per cent. of the sample, was rotted internally. It was observed that in one or two instances a slight amount of mould was present on the surface of fruits which were sound inside. The flesh of the majority of the sound mangosteens was white and attractive in appearance, juicy and of good flavour. A few fruits appeared to be over-ripe, and the flesh of these had lost its clear white colour and was tending to break down.

Samples of this consignment were not retained for observations on keeping quality.

The most important point in connection with this shipment is that although carried in cool storage both the almost ripe and the just ripening fruit contained a high proportion of wastage due to fungal rotting.

In the case of the almost ripe fruit a certain amount of ripening had taken place during the voyage, while that picked at the just ripening stage did not appear to have ripened to any degree.

4. SECOND SHIPMENT

The second consignment was shipped from Rangoon on the 7th May and arrived at Tilbury dock on the 8th June. The consignment consisted as before of 1,000 fruits, 500 picked when almost ripe, and 500 picked when just ripening. They were packed in wooden trays each holding 25 fruits.

The average temperature of carriage was stated to have been 53°F. The self registering thermometer carried with the fruit indicated that the highest and lowest temperatures had been 54°F. and 48°F.

An examination of two cases of the fruit was carried out on board the ship. It was evident that the fruit was in somewhat better condition than that of the previous consignment and arrangements were, therefore, made for the majority of it to be placed on the market as quickly as possible. Samples were forwarded to the Covent Garden Laboratory for detailed examination.

5. CONDITION ON ARRIVAL

Just Ripening Fruit.—A sample of 36 fruits at the just ripening stage of maturity was examined at the laboratory. The colour was somewhat variable and a number of the fruits had rinds which were either hard or

commencing to harden. The fruits were clean and the majority appeared to be sound. Three fruits showed slight mould growth on the surface, when cut one of these was found to be rotted internally, the other two were sound.

Eleven of the remaining 33 fruits were cut, the flesh of all was sound, although 2 showed slight mould growth on the inner surface of the rind. The flavour was poor.

A week later the remainder of the sample, 22 fruits, was cut. The rinds of many of the fruits had become brown while all were hard and it was found that all except 5 were rotted.

Almost Ripe Fruit.—The almost ripe fruit was clean and attractive in appearance and deep purple in colour. A sample of 20 fruits was examined in detail. In 13 hardening of the rinds had taken place; the remainder had soft rinds. A sample of 12, the majority with hard rinds, was cut, and one was found to be slightly rotted. All the sound fruits were fully ripe. The flesh generally was in good condition and the flavour excellent. The remaining 8 fruits were retained for a week and then cut; 7 were then rotted.

As far as could be judged the second consignment was in somewhat better condition on arrival than the first. Nevertheless many fruits showed evidence of fungal infection and samples retained at ordinary temperatures developed extensive wastage within a week.

6. NATURE OF WASTAGE

The wastage present in the two consignments appeared to be similar in type to that which was present in previous shipments. In slightly rotted fruits it could be seen that infection had started from the stem end. The pulp of such fruit on keeping gradually became dark grey or black in colour and covered with mould. In very advanced rotting the whole of the fruit was involved and the rind was covered with a black mould growth. The rind alone was sometimes affected. At other times the rind appeared to be perfectly sound while the interior of the fruit was completely rotted.

A brief examination of the principal fungi present in a sample of rotted fruits was carried out at the Imperial Mycological Institute by Miss Hellinger of the Tel-Aviv Agricultural Experiment Station, Palestine.

The organisms identified were *Diplodia gossypina* (*Botryodiplodia theobromae*), *Pestalozzia* sp., *Phomopsis* sp., *Gloeosporium* sp., and *Rhizopus nigricans*. Except for the last named which is essentially a storage rot organism, all these organisms are found on the tree.

In view of the nature of the infection it is evident that the majority of the wastage at the time of discharge was due to infection while the fruit was on the tree. According to preshipment information more than 25 per cent. of the fruit intended for canning was found to be rotted.

It was mentioned in an earlier report that the growth of Diplodia is retarded by storage at temperatures below 55°F. Wastage in fruit infected by this organism increases rapidly, however, when storage at a higher temperature is resumed. The fact that within a week the wastage was well over 50 per cent. indicates fairly conclusively that a very large proportion of the fruit was infected at the time of picking.

The presence of infection which subsequently leads to extensive wastage in fruit destined for export is a serious matter. This becomes still more serious when on the market, the unsound fruits cannot be sorted out from the sound ones with any degree of certainty. As already mentioned unsound fruit often appeared externally to be sound. Hardening of the rind can not be regarded as a reliable guide as sound fruits were observed to have hard rinds.

The sale of such fruit naturally often leads to disappointment on the part of the buyer with loss of confidence when future purchases are contemplated. In view of this it is strongly recommended that before further shipments are made steps should be taken to ensure that fruit at the time of packing is sound and free from infection by orchard rot organisms.

It has been previously pointed out that this can probably only be achieved by orchard sanitation, including spraying, pruning away and burning all dead twigs and branches.

7. MATURITY

At the time of discharge an effective comparison was possible between the just ripening and the almost ripe fruit.

The just ripening fruit was uneven in colour, almost fully green in some instances. Little ripening appeared to have taken place during the voyage. The flesh of the ripest fruits, that is those with an even red colour, was attractive in appearance, juicy and of fairly good flavour. The green fruit was unsatisfactory, the flesh clung to the rind and was hard and unpalatable.

The fruit picked when almost ripe was attractive in appearance. The flesh was in most instances attractive, clear white in colour, soft, juicy and of excellent flavour.

A few fruits in this class, from each shipment, were over-ripe, the rest were fully ripe.

It thus appears that for export under cool storage conditions the fruit should be picked at an almost ripe stage.

8. PACKING

The method of packing adopted was satisfactory and the fruit was free from mechanical injury. The mangosteens were individually wrapped in unglazed paper and packed in a single layer in trays measuring 18 in. by 12 in. by 2½ in., and each holding 25 fruits. The trays were smaller than those used for previous consignments. Wood wool was used as a packing material.

9. MARKETING

The demand for the first shipment of mangosteens was good. The fruit was sorted at the warehouse in order to eliminate as far as possible unripe and rotted fruit and 384 fruits were sold.

The demand for the second consignment was better than for the first consignment and the fruit was sold without sorting.

ACCOUNT SALES

First Consignment.

	£.	s.	d.
27 dozen fruits at 4.0 per dozen	5	8	0
5 dozen fruits at 2.6 per dozen		12	6
	6	0	6

Second Consignment.

36 trays	14.0 per tray	25	4	0

STATEMENT OF ACCOUNTS

Receipts	£.	s.	d.	Payments	£.	s.	d.
First Consignment	6	0	6	Carriage from Tilbury to London (First consignment)	1	0	0
Second Consignment	25	4	0	Sale charges and commission (First consignment)		17	4
	31	4	6	Carriage from Tilbury Sale charges and commission inclusive second consignment	4	2	3
				Nett proceeds	25	4	11
					31	4	6

A certain amount of publicity was given to the arrival of this fruit and this accounted for the keen demand.

It should be borne in mind that for fruit from a new source to command a market it is essential that it should be sound. The purchase of unsound fruit, under the belief that it is sound, creates a bad impression which tends to remain fixed long after the cause has been removed. The probable cause and extent of wastage have already been pointed out and it is strongly recommended that before further shipments are sent efforts should be made to eradicate the cause of wastage.

With regard to future demand, the opinions were similar to those obtained in 1931. It was considered that the demand would be very limited and would come mainly from large stores. The product was in the nature of a speciality and would not appeal to the general public.

10. CANNED FRUIT

A case containing 20 tins of canned fruit was sent with each shipment of fresh fruit. Each case contained the following:

4 tins of fruit in 50 per cent. syrup,

2 tins sterilized for 10 minutes, and
2 tins sterilized for 5 minutes,

4 tins of fruit in 40 per cent. syrup,

2 tins sterilized for 10 minutes, and
2 tins sterilized for 5 minutes.

4 tins of fruit in 30 per cent. syrup,
2 tins sterilized for 10 minutes, and
2 tins sterilized for 5 minutes.

4 tins of fruit in 20 per cent. syrup,
2 tins sterilized for 10 minutes, and
2 tins sterilized for 5 minutes.

4 tins of fruit in 10 per cent. syrup,
2 tins sterilized for 10 minutes, and
2 tins sterilized for 5 minutes.

The first consignment was not examined immediately after arrival, as an opportunity to obtain trade opinion was awaited, and it was eventually examined along with the second consignment when that arrived.

On arrival the tins of the first consignment appeared to be sound, but when examined at a later date it was found that one of the tins containing 50 per cent. syrup sterilized for 5 minutes was blown, and the contents of the other tin had commenced to ferment. In the second consignment all the tins containing 50 per cent. syrup were blown, together with the tins containing 40 per cent. and 30 per cent. syrup sterilized for 5 minutes.

On the whole the condition of the first consignment was better than that of the second. In the tins of the first consignment the syrup was clear and the fruit of good colour, while in those of the second consignment the syrup was cloudy and the fruit poor in colour. In both shipments the segments of fruit were firm and showed no tendency to pulp.

Comparative tests carried out at Covent Garden Laboratory, showed that the fruit sterilized for 5 minutes was in every case somewhat fresher in flavour than that sterilized for 10 minutes, in the latter a slightly cooked flavour was just apparent. The fruit in 10 per cent. and 20 per cent. syrup was insipid in flavour, that in 30 per cent., 40 per cent. and 50 per cent. syrup was fairly good. The fruit in 40 per cent. syrup appeared to be most satisfactory. It was difficult to detect the flavour of the fresh mangosteen and it would appear that this fruit does not lend itself to canning as it possesses a delicate flavour which is either masked or destroyed by the process.

11. TRADE OPINIONS

Samples of the fruit in 30 per cent. and 40 per cent. syrup sterilized for 5 minutes and 10 minutes and in 50 per cent. syrup sterilized for 10 minutes were submitted to the trade.

The fruit was considered to be somewhat unattractive in appearance and insipid in flavour. The sugar content of the syrup was measured and was found to be only 14 to 16 per cent. It was stated that a good quality product should have a syrup containing at least 25 per cent. sugar.

As fermentation had occurred it seems that sterilization for a period up to 10 minutes is incomplete at 180°F. and it is suggested that further experiments be carried out in Burma to determine the minimum time and temperature which would ensure sterilization.

12. SUMMARY

1. The condition of the two shipments was similar. The quality of the almost ripe fruit was rather better in the second than in the first shipment. Rather less wastage was present on arrival than was present in the shipment of the previous year.

2. The fruit picked when just ripening was of variable maturity. The flesh generally was poor in flavour and rather hard. Wastage on arrival was more than 10 per cent. in both shipments.

3. The fruit picked when almost ripe was attractive in appearance. Sound fruits, with the exception of a few which appeared to be over-ripe, were fully ripe. The flesh was attractive in appearance and the flavour good. Wastage in this fruit on arrival was 25 per cent. in the first shipment and slightly less than 10 per cent. in the second.

4. The rotted fruits had developed a hardening of the rind. Hardening of the rind was also observed in certain fruits which appeared to be sound.

5. Samples of the fruit from the second shipment kept for a week developed well over 50 per cent. wastage.

6. The organisms responsible for the majority of the wastage live in the orchard and it is highly probable that most of the infection occurred while the fruit was still on the tree. It is recommended that efforts should be made to considerably reduce the infection by orchard sanitation.

7. The fruit picked when just ripening had not ripened during the voyage and was in poor condition for marketing. The best stage at which to pick appears to be when the fruit is almost ripe.

8. The demand for the mangosteens was good but in order to gain and keep a market it is essential that the fruit should be reliable and commercial shipments should not be continued until wastage can be considerably reduced.

9. In the canned fruit fermentation had occurred in certain tins in both shipments. In the first shipment fruit in 30 per cent. syrup sterilized for 5 minutes was fermenting and in the second shipment fruit in 50, 40 and 30 per cent. syrup sterilized for 5 minutes and in 50 per cent. syrup sterilized for 10 minutes was fermenting.

10. The best flavoured product was that in 40 per cent. syrup sterilized for 5 minutes. A slightly cooked flavour was apparent in the fruit sterilized for 10 minutes.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31 JANUARY, 1933

Province, &c.	Disease	No. of Cases up to Date since Jan. 1st 1933	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	22	22	21	1	...	...
	Anthrax	...	...	...	...	..	...
	Rabies (Dogs)	...	...	...	...	...	...
	Piroplasmosis	...	...		...	...	...
Colombo Municipality	Rinderpest	..	...	...	...	...	...
	Foot-and-mouth disease	26	26	7	...	19	...
	Anthrax	1	1	...	1	...	...
	Rabies (Dogs)	5	5	...	...	...	5
	Haemorrhagic Septicaemia	...	...	...	...	...	...
	Black Quarter	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	...	...	...	
Cattle Quarantine Station	Rinderpest	.	...	...	...	...	...
	Foot-and-mouth disease	19*	19	4	1	14	...
	Anthrax (Sheep & Goats)	6*	6	...	6	...	...
Central	Rinderpest	17	17	...	12	3	2
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	6	6	...	6	...	..
	Black Quarter	...	...	.	...	...	...
	Rabies (Dogs)	...	...	...	...	...	...
Southern	Rinderpest Foot-and-mouth disease Anthrax Rabies (Dogs)	FREE					
Northern	Rinderpest	28	28	6	16	5	1
	Foot-and-mouth disease	4	4	4	...	...	...
	Anthrax	...	...	...	...	...	..
	Black Quarter	..	...	...	...	...	...
	Rabies (Dogs)	...	...	...	...	...	...
Eastern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	52	52	51	1	..	...
	Anthrax	...	...	...	...	...	...
North-Western	Rinderpest Foot-and-mouth disease Anthrax Rabies (a bull)	FREE					
North-Central	Rinderpest	322	322	63	243	11	5
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest Foot-and-mouth disease Anthrax Rabies (Dogs)	FREE					
Sabaragamuwa	Rinderpest Foot-and-mouth disease Anthrax Piroplasmosis Haemorrhagic Septicaemia Rabies (Dogs)	FREE					

* Among Sheep and Goats.

G. V. S. Office.
Colombo, 7th February, 1933.

MARTIN WIJAYANAYAKA,
for Govt. Veterinary Surgeon.

METEOROLOGICAL REPORT, JANUARY, 1933

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Inches		Inches
Colombo -	85·7	− 1·0	73·0	+ 1·2	76	95	7·4	6·57	17	+ 2·81
Puttalam -	84·5	− 1·0	71·6	+ 1·7	80	95	6·9	4·60	15	+ 1·83
Mannar -	82·4	− 1·8	75·2	+ 1·1	79	86	7·6	3·20	12	+ 0·40
Jaffna -	83·1	+ 0·4	72·2	0	81	93	5·5	4·92	13	+ 2·01
Trincomalee -	80·6	0	75·4	+ 0·4	85	88	7·7	8·91	23	+ 2·09
Batticaloa -	81·7	+ 0·1	74·3	+ 0·7	83	90	6·4	28·07	27	+ 17·82
Hambantota -	83·3	− 2·4	73·7	+ 1·1	80	93	6·5	14·81	21	+ 11·42
Galle -	83·6	− 1·1	73·8	+ 1·3	83	93	6·9	7·34	21	+ 3·17
Ratnapura -	86·4	− 3·7	72·4	+ 1·6	82	95	7·4	9·46	21	+ 3·94
A'pura -	81·8	− 0·6	71·3	+ 2·3	82	95	8·2	10·18	17	+ 6·21
Kurunegala -	84·7	− 1·8	71·9	+ 2·1	78	90	8·6	14·12	21	+ 10·34
Kandy -	79·5	− 3·7	68·8	+ 1·9	80	90	8·0	16·61	23	+ 11·31
Badulla -	74·2	− 2·5	66·4	+ 3·1	89	97	8·6	31·73	28	+ 22·25
Diyatalawa -	69·1	− 3·3	60·9	+ 4·0	88	94	9·2	23·05	27	+ 17·16
Hakgala -	63·2	− 5·1	55·3	+ 3·9	96	97	8·9	37·21	28	+ 27·10
N'Eliya -	63·2	− 4·9	53·3	+ 8·5	85	91	8·3	25·38	25	+ 19·63

The rainfall of January was nearly everywhere above average and considerably so over the greater part of the Island, excesses being particularly marked in the eastern half of the Central Province, where St. Martin's and Hendon with totals of 123·09 and 122·20 inches respectively for the month were as much as 87 and 86 inches in excess. Strangely enough these were just the two stations that recorded the largest deficits in December. The records of St. Martin's Estate go back 47 years but the only other occasion when more than 100 inches were registered there in a month was in January 1913. Two other stations Dooroomadella Estate and Kurundu Oya Estate had excesses of over 50 inches for the month, while excesses of over 40 inches were recorded at Gammaduwa, Maha Oya, Kabaragalla, Madugoda, Patiagama, Bulugahapitiya, Hope, Maturata, Kobonella, Liddesdale and Mahadova. On the whole the eastern half of the Island came in for the larger share of the rain, which is in keeping with the normal distribution for January, though it must be emphasised that the actual quantities registered were extraordinarily high, and quite a number of stations in the Central, Uva and Eastern Provinces broke their previous records for January.

A few stations in the Jaffna Peninsula and in the Southern Province recorded slight deficits. Besides these Marambekande in Sabaragamuwa and Kebetigollewa in the North-Central Province were below average for the month. Vadamarachchi with 3·46 inches below average recorded the largest deficit.

There were as many as 15 falls of over 8 inches and more than 125 falls of over 5 inches in a rainfall day, the largest fall being 12·50 inches at Maha Oya on the 6th-7th. The majority of these falls occurred on the 4th-7th, 17th-19th, and during the last two days of the month.

The pressure was below normal during most of the month but the northerly gradient was definitely steeper than usual and the winds in consequence above average strength, particularly in the north and east of the Island. On the whole, the north-east monsoonal activity was well pronounced and accounted for most of the rain.

Temperatures were consistently below average by day and above average by night. Both humidity and cloud were well above average.

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